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# REPORTS

OF THE

# DEPARTMENT OF COMMERCE

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## 1919

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## REPORT OF THE SECRETARY OF COMMERCE

AND

## REPORTS OF BUREAUS

WASHINGTON
GOVERNMENT PRINTING OFFICE
1920

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# REPORT

OF THE

# SECRETARY OF COMMERCE

# ANNUAL REPORT

OF THE

# SECRETARY OF COMMERCE.

DEPARTMENT OF COMMERCE,
OFFICE OF THE SECRETARY,
*Washington, October 30, 1919.*

To the PRESIDENT:

I have the honor to submit herewith my seventh annual report, covering the operations and condition of the Department during the fiscal year which ended June 30, 1919, and tracing in a general way its operations to October 1 of the present year.

Recommendations have hitherto been often made respecting the inadequate subsistence allowance for Department employees when traveling. Force is added to these by present prices. It has always been wrong to require Government officers when traveling to pay out of their own pockets part of the cost of the public work they do. The situation is worse to-day. This injustice can not be too speedily corrected, either by increasing the subsistence allowances or by authorizing some flexibility in the matter under the direction of the Secretary.

It has been heretofore pointed out that the Bureau of Standards may and does send its representatives to meetings and conventions at public expense. The law especially permits this. It does not, however, grant a like privilege to the representatives of the Coast and Geodetic Survey, the Bureau of Fisheries, the Bureau of the Census, and other services. The same obligation and usefulness exists as regards this matter in connection with the work of all services. There is no reason why one bureau should be preferred to others. The privilege should be extended to all alike.

Your attention is particularly asked to Appendix B, giving in detail the record of the efforts of the Bureau of Fisheries to introduce new foods, in connection with statements that have been made in Congress respecting this work. The successful work of this service in developing the use of existing aquatic foods and in introducing new ones has been stopped because one part of its work was confused with another part which has no relation to the matter. It has been thought best, therefore, to make the whole record clear in this report.

### American-Canadian Fisheries Conference.

The appointment of the American-Canadian Fisheries Conference and its general purpose were referred to in my annual report for last year (p. 7).

Some of the questions that came before the conference are as old as the American Republic, others are of comparatively recent origin; and they differ greatly in national and international importance. Some of the questions were satisfactorily disposed of by executive action of the two countries, some can be settled only by treaty and others by legislation, and at least one was left for fuller consideration at a more auspicious time.

During the course of the inquiries conducted, action was taken as follows in the settlement of pending questions, or as affecting the fishery relations of the two countries:

1. The Canadian Government, by order in council, prohibited net fishing in Lake Champlain and thus gave to fish in the Quebec portion of the lake the same protection that was already afforded in New York and Vermont.

2. The Canadian Government, by order in council, modified the provisions of the modus vivendi so as to accord fuller facilities to American fishing vessels using Canadian ports and harbors.

3. The United States Government, by order of the Department of Commerce, permitted Canadian fishing vessels (and the fishing vessels of other nations acting with the United States in the prosecution of the war) to enter United States ports from the fishing grounds and clear for the high seas, this authority, however, like that granted by the Canadian Government in extension of the modus vivendi, being a war measure.

4. The United States Government, by order of the Department of Commerce, removed discriminatory navigational regulations applying to Canadian fishing vessels passing through the territorial waters of Alaska to and from the fishing grounds on the high seas.

A treaty covering the subject of reciprocal port privileges for the fishing vessels of the United States and Canada is pending.

Legislation is before Congress to restrict the use of lobster well-smacks by citizens of the United States in waters off the Canadian coast when there is a close time on lobster fishing in Canada, but no affirmative action has been taken on the measure.

Recommendations have been made to the respective Governments in regard to the protection of the Pacific halibut and the protection of sturgeons, and action thereon is pending. The international protection of whales, which the conference regarded as deserving careful attention, was recommended for consideration at a later date.

The protection and rehabilitation of the sockeye salmon fisheries in the contiguous waters of the State of Washington and the Province of British Columbia, perhaps the most important subject considered by the conference, was covered by a comprehensive system of regulations recommended for the adoption of the two countries. A treaty covering this subject was signed by the representatives of Great Britain, Canada, and the United States on September 2, 1919.

## Vessels of the Department's Marine Services.

The steamer *Surveyor*, the only vessel especially designed and constructed for the work of the Coast and Geodetic Survey, went into the Navy a month after completion. The ship returned to the Survey with the honor of having assisted in disabling, on May 17, 1918, the German submarine *U-39*, which sank the *Lusitania*. She is now at her post of duty in Alaska and there provides for the first time a vessel adequate to the vast and difficult work of surveying those dangerous waters, the scene of so many disastrous wrecks. The *Surveyor* alone, indeed, is not sufficient for the task of covering the 26,000 miles of coast to be surveyed in Alaska. She will be assisted by other vessels which the Navy has turned over for that purpose, namely, the *Sialia*, the *Natoma*, and the *Wenonah*. Even with this equipment, now for the first time available, it will be long years before the waters of Alaska will be so well charted that they can be traversed in all parts with confidence. Great as the development of Alaska has been, it has been held back, as every navigator of those waters knows, by the failure of the country heretofore to visualize the size of the task of surveying its shores. We have waited until a sad series of wrecks, with their accompanying losses of life and property, have shocked us into activity in work which should have been adequately undertaken decades ago.

For the first time launches designed and built for the special duty have been provided for the wire-drag work of this service, and with these and two others which the Navy Department turned over to us under your Executive order of May 24. 1919, we are now able to carry on this important work in Alaska with more effectiveness. It is strange that in order to do a great duty of peace we should have to depend upon supplies assembled for war. It does not reflect credit upon our judgment and foresight that this should be so, but it is well to be thankful for what we have without worrying as to the way in which it came. The fact is that the Coast and Geodetic Survey has some vessels for service and a few launches for wire-drag work and that if sufficient funds are provided for their use and for the necessary field and office forces and equipment, the service is in a position to give assurance to our commerce and navigation of safety in all our waters such as it never had before.

On July 1, 1919, the Navy Department returned to the Bureau of Lighthouses 47 lighthouse tenders and 4 light vessels, transferred to that department for war uses by your Executive order of April 11, 1917. This Service has also acquired two small vessels (*Cosmos* and *Poinsettia*) from the Navy Department and during the year built two small tenders (*Elm* and *Pine*). Six lighthouse vessels have recently been lost: Diamond Shoal Light Vessel No. 71 was sunk by enemy submarine on August 6, 1918; Cross Rip Light Vessel No. 6 was destroyed by the ice in February, 1918; while in the shipyard awaiting repairs necessitated by damages from ice, the 35 Foot Channel Light Vessel No. 45 was burned on March 3, 1918; Relief Light Vessel No. 51 was sunk on Cornfield Point light vessel station by Standard Oil Co.'s barge on April 24, 1919; the tender *Gardenia*, after 40 years of valuable service, was condemned on March 1, 1917, as was Bush Bluff Light Vessel No. 97 on October 23, 1918, after 43 years of service.

The commandant of the fifth naval district, in his formal letter of June 30, 1919, returning some vessels of the Lighthouse Service to this Department, says:

> The district commandant wishes to use this opportunity to express his high appreciation of the cordial cooperation of the Lighthouse Service in the solution of many problems arising during the period when they were under Navy control. The Lighthouse Service has responded quickly and efficiently to every demand made upon them by the naval district. The services of the lighthouse vessels were of immense value in the laying of submarine-defense nets and, after the armistice, in removing those nets. This was a task which would hardly be possible of accomplishment without the assistance of the lighthouse vessels.

The Navy Department has also turned over to the Bureau of Fisheries four scout patrol boats, two of which will be used as patrol boats in southeastern Alaskan waters and two for fish-cultural work. Four vessels, loaned by this bureau to the Navy Department during the war, have been returned. The *Roosevelt* was condemned and sold in early July of this year. The bureau purchased the *Eider*, formerly a deep-sea halibut vessel, for use as a tender between the Pribilof Islands and Alaskan Peninsula.

The work of the motor-vessel fleet of the Bureau of Navigation has been greatly increased because of the admirable working arrangement made with the Treasury Department, whereby such boats enforce not only the navigation and motor-boat laws, but the internal-revenue tax laws also applying to motor vessels. By this arrangement the Department has furnished during the fiscal year the motor vessels *Kilkenny* and *Tarragon*, with their officers and crews, and the Internal Revenue Bureau of the Treasury Department supplied the sum of $5,000 as a part contribution toward the cost of fuel for the vessels, and paid also the salary of one officer.

Late in the year the motor vessel *Dixie*, belonging to this service, was restored by the Navy, and in addition two other vessels, the *Siwash* and *Psyche II*, were turned over by them, so that the service will have during the current fiscal year five good motor vessels. The record of the past year shows the same satisfactory results as in previous years, but the number of vessels was less because the *Dixie* was in the Navy.

The mitigated fines and taxes collected as a result more than paid for the service. The work done for the Treasury resulted in the collections of large sums that would otherwise have been lost to sight, and was fully satisfactory to the officers of that Department.

It is proposed in the next calendar year to station the *Siwash* to cover the coast from New York east, the *Kilkenny* to patrol from New York to Wilmington, N. C., including Delaware and Chesapeake Bays and North Carolina sounds, the *Tarragon* to cover South Carolina and Florida waters, the *Dixie* the Mississippi River and tributaries and the Gulf coast, and the *Psyche II* to be on the Great Lakes. Full operation of these vessels in these areas will be contingent upon the funds available for their use. It can not be, however, emphasized too often that the work done by these patrol boats in enforcing the navigation laws in connection with vessels plying our rivers, bays, sounds, and the inland waters along our coasts insures safety to navigation both for large and small vessels, and collects taxes which otherwise would not be collected, in such a way as to cost the Nation nothing, because the penalties which are imposed for violations, together with the taxes gathered, more than cover the cost of the boats and their repairs, maintenance, and operation.

The Department had the following vessels in its marine service on October 1, 1919:

| Service. | In operation. | Not in operation. | Being built. | Sold. | Bought. | Turned over by Navy. | Loaned to Navy. | Returned by Navy. | Total. |
|---|---|---|---|---|---|---|---|---|---|
| Coast and Geodetic Survey | 15 | ........ | ....... | 1 | .......... | 5 | ......... | 5 | 15 |
| Bureau of Navigation | 2 | 2 | ....... | ....... | .......... | ......... | 1 | .......... | 5 |
| Bureau of Lighthouses: | | | | | | | | | |
| Tenders | 54 | 1 | ....... | ....... | .......... | 2 | 47 | 47 | 54 |
| Vessels | 63 | 2 | 2 | ....... | .......... | ......... | 4 | [a]3 | 63 |
| Bureau of Fisheries | 9 | ........ | ....... | 1 | 1 | 4 | ......... | 5 | ....... |
| Total | 143 | 5 | 2 | 2 | 1 | 11 | 52 | 60 | 137 |

[a] One sunk.

This is exclusive of 2 vessels loaned to the Coast and Geodetic Survey by the Philippine Government and of 54 motor boats of all sizes operated by the Bureau of Fisheries, and a large number of launches used at the various stations of the Lighthouse Service.

Incidentally it is worth mentioning that the steamer *Surveyor*, being constructed with that in mind, was ready without a day's delay to enter the naval service. Her successors will be similarly designed and built. It should be the case that every vessel of every maritime service of the Government should be designed so that if needed for the national defense they would be ready without alteration to do their special part. Such is the definite plan of this Department in the vessels that it builds, and it takes no small pride in the contribution that its ships, small as they are, rendered the national cause.

**Vessels Urgently Needed for the Bureau of Lighthouses.**

In the operation of the Lighthouse Service, covering 47,300 miles of general coast line and rivers, there are at present employed 54 lighthouse tenders and 63 light vessels, 117 in all. To maintain this number 2 tenders and 2 light vessels should be built each year, and recommendations and estimates submitted yearly have emphasized this fact.

Since 1910 the number of aids to navigation has increased from 11,660 to 16,075, a total increase of 4,415, or 38 per cent. This increase has added greatly to the work of the tenders, so that the present number has become inadequate to maintain the service as required in the interests of navigation. There has also been an unusual number of casualties to vessels recently, 6 vessels having been lost, or condemned, as before stated.

As a result of careful study of the matter, it has been found that within the next five years 18 light vessels and 10 tenders should be replaced, and funds should be provided now for 17 of these vessels most urgently needed.

On May 15, 1919, in a letter to the Speaker of the House of Representatives, request has been made for a provision authorizing the construction or purchasing and equipping lighthouse tenders and light vessels for the Lighthouse Service of $5,000,000. (See Appendix A.)

**Buildings.**

The buildings occupied by the Department of Commerce are:

1. Commerce Building, Nineteenth Street and Pennsylvania Avenue NW.

2. Bureau of Fisheries Building, Sixth and B Streets SW., and new adjoining fishery products laboratory.

3. Coast and Geodetic Survey Building, New Jersey Avenue near B Street SW., directly opposite the House of Representatives Office Building, and new adjoining chart, instrument, and archives building.

4. The Bureau of Standards, Pierce Mill Road, near Connecticut Avenue, is housed in 13 principal buildings and 7 minor buildings, 5 of the latter being temporary structures.

The fishery products laboratory had its rise in the necessity of developing under war conditions, as rapidly and broadly as possible, additional food supplies. Funds for the building were provided from the appropriation for the national security and defense. This laboratory is unique and its operations are expected to have a great and beneficial effect upon the fish industries and upon the food supplies obtained from them.

The new building for the Coast and Geodetic Survey, for which provision was made from the fund for the national security and defense, though long delayed in its construction by the difficulty of securing the necessary materials during the war and since its close, is completed and its equipment in place. It was none too soon to meet the vastly increased demands for charts and service arising from the great increase in our merchant marine. If it is considered that to this well-known growth there was added also during the war an immensely increased demand for charts for the Navy, it will be clear that this service was called upon for an enormous expansion of its work at a time when a very large portion of its staff was absent, serving either in the Army or Navy at home and abroad, and when most of its vessels were taken from their regular duties to do naval work. It was only by untiring efforts, with equipment not intended for any such emergency, that sufficient charts were ready for the vessels as they were wanted. Fortunately, the crisis was met by new equipment, procured from war funds, without which the situation would have been serious. The new Harris automatic press was put into operation on January 7, and immediately made possible the mechanical production of charts in sufficient numbers to meet the need. The service is now better equipped than at any time in its history for the rapid production of charts, so far as its mechanical appliances are concerned

The new building for the first time provides fireproof protection for the valuable records of the Coast and Geodetic Survey. which cover a period of over 100 years and represent an actual cash outlay of many millions of dollars.

These two buildings, in common with several erected at the Bureau of Standards, though built during and for the war, were so designed as to be equally useful and effective in peace. Every dollar of their cost is an investment, and not an expense, and will be permanently productive.

Land for a new building was acquired for what was then the Department of Commerce and Labor under the act of May 30, 1908 (35 Stat., 545), and, by the act of June 25, 1910 (36 Stat., 698), the Secretary of the Treasury was directed to prepare designs and estimates for a fireproof building to occupy the new site. On March 3, 1913, the plans for the proposed building were approved by my predecessor. Since that time three bureaus of the former Department have been transferred to the Department of Labor; one has gone to the Federal Trade Commission; two of the present services were omitted from the plans. The new building, when redesigned, should be made to accommodate the office, the lithographing establishment with its accessories, the drawing room, and the instrument shop of the Coast and Geodetic Survey, and the administrative offices, and, if practicable, the laboratory of the Bureau of Fisheries. When this is done the property on Capitol Hill, adjoining the Public Health Service, opposite the House Office Building and near the Capitol itself, now occupied by the Coast and Geodetic Survey, could be used for other Government purposes, and in like manner the buildings now occupied by the Bureau of Fisheries will become available for other uses. The new buildings erected in connection with these two services are so designed as to be useful in other connections.

Five of the eight services of the Department, as well as the divisions of the Secretary's Office, are housed in the Commerce Building. The normal growth of these services, which are the Bureaus of the Census, Foreign and Domestic Commerce, Navigation, Lighthouses, and the Steamboat-Inspection Service, will overcrowd the building before the new one can be constructed. During the present year it has been necessary to house the division of statistics of the Bureau of Foreign and Domestic Commerce in the building occupied by the Council of National Defense.

The annual rental of the Commerce Building is $65,500. This is at the rate of $0.358 per square foot, gross. The lease of the building was renewed on July 1, 1919, for five years. During the pendency of this new lease the proposed Commerce Building should be redesigned and constructed, so as to be occupied by or before the lease terminates. In addition we are now paying an annual rental of $1,225 for 4,900 square feet of storage space.

The comments heretofore made respecting the unfitness of the buildings occupied by the Coast and Geodetic Survey and by the Bureau of Fisheries are renewed. Reference is made to pages 10 and 11 of my annual report for 1918 and pages 218 to 220 of my annual report for 1917.

**Bureau of Standards—Industrial Laboratory Building.**

The great demands placed upon the bureau by the Government's war program made it necessary, early in the year, to build a larger laboratory building to house the work along the lines of structural materials and industrial research and related subjects.

The building is four stories, including basement, and has a frontage of 351 feet and depth of 166 feet. The main wings are 62 feet wide and the extensions 105 feet, forming an E-shaped ground plan.

The entire center wing is of special construction to provide for large testing machines. The central part is open from basement to third floor, with galleries surrounding the open well at first and second floor levels. The central well will ultimately be occupied by large vertical testing machines and the galleries by smaller testing machines. The two vacant spaces included in the E form of building have one-story courts covered by concrete roofs, each lighted by three large skylights.

Directly north of this building, separated from it by a driveway, is the new, one-story kiln building, 50 by 350 feet, which houses in its basement the heating plant for these two buildings. The end walls are connected with the industrial laboratory building by a brick wall, which contains an open archway for a driveway, so that the two buildings are in effect one large unit.

In the west extension is housed the section on cement, concrete, and building stone. It is fully provided with all necessary equipment for carrying out the research studies in this line, as well as attending to the large demands for routine tests of cement and concrete. Space is also provided for chemical research in the manufacture of cement.

On the second floor are the laboratories and offices of the section on lime, magnesite, and gypsum, these branches being similar in character to the cement work.

Various portions of the building are occupied by the sections on clay products and optical glass. They occupy the entire west court, which is equipped with special grinding machinery. The several types of furnaces used in the study and manufacture of these products are installed in the kiln house.

The central extension and the surrounding space for three floors are occupied by the metals-testing section, which is fully equipped to handle all physical tests of metals and metal structures, etc. The basement of the east extension will house the large horizontal Emery machine. When the installation of these machines is completed, this will be the most complete materials-testing laboratory, with machines of the largest capacity, in the world.

The work in textiles, paper, leather, and rubber is housed in the east part of the building, equipped with a large chamber in which is maintained an atmosphere of constant humidity and constant temperature and various types of machinery necessary for the manufacture and research work in these materials.

On the third floor, in the central section of the building, are the laboratories for the work on lubricating oils.

The east court houses a machine shop for repairing the testing machines, preparing test specimens, and making new apparatus as required by the various lines of research.

The bureau's photographic department has a complete laboratory in the center wing on the third floor and is equipped to handle a large range of photographic work, from blue printing to the making of moving pictures.

Space is also allotted for a museum and display room to exhibit the various products and specimens of work accomplished, for a general library of books and periodicals dealing with industrial subjects, and for a lunch room and kitchen required to serve meals to the employees of the building.

### Bureau of Standards—New Dynamometer and Altitude Laboratory.

The temporary wooden buildings, in which the altitude and dynamometer laboratories have been housed for the last year and a half, have now been replaced by a permanent structure of brick and concrete. This building has a rectangular floor plan measuring 50 by 150 feet.

### Bureau of Fisheries—Laboratory Aquarium.

I have twice called attention to the need of a laboratory aquarium for the Bureau of Fisheries. (See pp. 12–14 of my annual report for 1917, and p. 11 of my report for 1918.) The prevailing cost of food is a continued, forceful argument in favor of the erection of this building.

It is true, of course, that in those features common to aquaria, the institution would be a source of education as well as of general popular interest, as are all of the famous aquaria. This, while valuable, is, however, not the essential purpose on which stress should be laid. Most important is the use of the aquarium as a laboratory for selecting and developing fishes as food, for their definite cultivation as food-producing animals, for treating this whole side of the animal kingdom with the same study and care as regards its possible service to mankind as is given to breeding cattle and sheep as producers either of dairy products or of meat and of wool and leather. It does not reflect special credit upon our intelligence that, while doing so much and so well upon certain phases of animal industry, we neglect, indeed leave entirely untouched, another phase of which we know only that great possibilities exist which we have not tried to develop.

Long ago the Bureau of Fisheries established the fact that an acre of water on the farm could be made as productive of food as an acre of land. We have agricultural colleges dealing with the land acre and a great Government department ably cooperating with them. The water acres of the world are more in extent than are those of the land, and we are blest as a Nation with possibilities for aquatic life along our coasts and in our Great Lakes and streams such as is given to no other people of the world, yet we have not a single such station as is proposed, wherein, at an investment less than many an agricultural college has cost, we may study an even greater extent of food-producing possibilities.

The experience of the Bureau of Fisheries has shown that he would be very rash who would put limits to what our water areas could do in supplying food of many kinds. To argue from the past in this matter is to argue from times of ignorance, for within the last five years many fishes have become objects of common food, of which men knew hardly at all, and this process in many respects is capable of what seems unlimited extension.

Whatever the cause of the high price of food, its effect should be to make men eagerly study how food can be made to cost less, and that is what is now proposed.

### Housing for the Bureau of the Census.

The Bureau of the Census will be housed during the census period, which began on July 1, 1919, in building "D," at Four-and-a-half Street and Missouri Avenue. The offices of the Director, of the division of manufactures, and of those portions of the service which are not specifically engaged upon the decennial census remain in the Commerce Building. The other branches have already been transferred to the new quarters and the force therein is being rapidly enlarged to cope with the work of the coming census. A clerical force of about 4,000 maximum will be employed in Washington on this work, and a great deal of space will be required for the many machines that will be used in tabulating the results of the census, and for storage for the millions of schedules containing the data gathered by the field force and the 300,000,000 or more cards which will be used in tabulating the population and agricultural statistics.

### Cooperation by the Bureau of the Census With Other Services and Organizations.

The Bureau of the Census and the Bureau of Education, Department of the Interior, are cooperating in taking the census of Alaska for 1920. The schedules, blanks, and other supplies have already been sent and work will begin immediately.

A conference was held between the Director of the Census, the chief statistician for manufactures of that bureau, and members of the National Industrial Conference Board of Boston and the National Association of Manufacturers, in order to insure the inclusion in the manufactures schedules of such inquiries as will be helpful and beneficial to industry. Schedules satisfactory to the industries and the bureau are being prepared.

The Geological Survey and the Bureau of Mines are cooperating in the compilation of information relative to the census of mines and quarries, in order to prevent duplication of work.

### Archives Building.

It is earnestly to be hoped that the archives building, a design for which was authorized by the public buildings act of March 4, 1913, may be promptly constructed. The Department of Commerce will need not less than 85,000 cubic feet of space therein, with such additional room as will provide for ready accession and constant use of the records of this Department, dating back to the beginnings of the Government.

### Urgent Needs of the Department.

Among the urgent needs of the Department are:

1. The provision of vessels for the Lighthouse Service, to which reference is made on preceding pages and in Appendix A.
2. The provision of funds to continue the work of the Lighthouse Service throughout the current fiscal year. The funds thus far appropriated are not sufficient, in view of necessary official increases of wages in other services, to carry the work of the Service much beyond the opening of the coming calendar year.
3. A building at the Bureau of Standards for a suitable power plant as recommended in my last annual report (p. 14).

4. A laboratory aquarium for the Bureau of Fisheries, treated earlier in this report.

5. A Government-owned building to house all the services of the Department, as recommended previously in this report.

6. An additional Assistant Secretary of Commerce to assist in the administration and supervision of the greatly increased work of the Department.

7. Special attention is invited to the recommendation under the title Steamboat-Inspection Service that the supervising inspectors of that important bureau be placed under the classified civil service.

A number of the urgent needs of the Department mentioned in my last report have already been met. Among these are:

1. The enlargement of the funds and the organization of the Bureau of Foreign and Domestic Commerce and a small but insufficient provision for more commercial attachés. The matter of proper payment for their clerks is still untouched.

2. Through the transfer of five vessels from the Navy the more urgent needs of the Coast Survey in this connection have been for the present met, and by the transfer of launches from the Navy the need for wire-drag launches in the Coast Survey is partly covered.

Following a suggestion made upon the floor of the House of Representatives by the former chairman of the Committee on Appropriations, Hon. Swagar Sherley, an effort was made with your approval to secure two special surveying steamers, similar in type to the *Surveyor*, from the United States Shipping Board, Emergency Fleet Corporation. The former chairman of the Shipping Board cooperated actively in the matter. At this writing, however, the subject is held up pending the discussion of certain legal questions, and its outcome is uncertain. Meanwhile the two vessels are greatly needed for deep-sea surveying, which can not be carried on upon any sufficient or properly economical scale without them.

3. An additional clerical force has been provided for the field work of the Steamboat-Inspection Service. An additional appropriation provided by the deficiency bill now pending may relieve the difficult situation in which the Coast and Geodetic Survey found itself by reason of the inadequate pay and the insufficient number of its draftsmen.

4. Provision was duly made for the census of 1920 and for housing the force necessary for that work.

5. An assistant has been provided for the Secretary of Commerce.

In the above way five out of eight urgent needs of the Department mentioned in my last report on pages 13 and 14 have in some measure received care.

### Use of Motion Pictures in Industry.

Developments during the year confirmed the opinion that motion pictures can be made an important factor in governmental foreign-trade promotion. Experimental work initiated and carried on in China by Commercial Attaché Julean Arnold has been so successful that it has been impossible to supply films enough to meet the demands. It is a significant fact that the Chinese are keenly interested in films showing quantity production in American industry.

There has, however, been no appropriation available for carrying on this work on a suitable scale. Such films as could be obtained without expense from interested and far-sighted firms were sent to Mr. Arnold, who got such distribution as he could through chambers of commerce and other bodies. The success attained in this way indicates what could be accomplished with sufficient funds to carry on the work on a broad scale in all promising fields.

The case for the motion picture as a means of promoting our foreign trade in foreign countries was presented at a special hearing on March 1, 1919, before the House Committee on Interstate and Foreign Commerce, when attention was called especially to the fact that the value of this means of trade promotion had been proved, and that other Governments were already using it.

Reference is made to House resolution 571, Sixty-fifth Congress, third session, and to the report of hearings on moving pictures as a means of commercial promotion.

### Pacific Cable Situation.

Existing facilities for transmitting cable messages across the Pacific Ocean are far from sufficient to meet the commercial demand. Chambers of commerce, business houses, and various commercial organizations have presented constant complaints of injurious delays, requesting that some remedy be applied adequate to meet the very unfortunate situation that exists.

The delays vitally impair the effectiveness of our foreign trade and have obliged business houses to undertake unusual and expensive expedients in order to transact their business at all.

We are in this important respect at a serious disadvantage compared with other commercial nations. Prices are often quoted and options given subject to acceptance within a given time, but in many cases when replies accepting quotations were delivered promptly to the cable they did not arrive in time to complete the transaction. There have, from this and similar reasons, been heavy losses in American export and import trade.

The subject has been one of careful study and of keen interest. On July 3, 1919, a report representing the joint views of the Bureau of Standards, the Bureau of Foreign and Domestic Commerce, and the then existing Industrial Cooperation Service was submitted to the Senate in connection with Senate bill No. 1651.

It is earnestly to be hoped that steps may be taken which will provide another cable under American control to the Far East, for to-day the United States is at a disadvantage in doing business with the Orient as compared with other countries.

**Appropriations and Expenditures.**

The itemized statement of the disbursements from the contingent fund of the Department of Commerce and the appropriation for "General expenses, Bureau of Standards," for the fiscal year ended June 30, 1919, required to be submitted to Congress by section 193 of the Revised Statutes of the United States; the itemized statement of expenditures under all appropriations for propagation of food fishes during the fiscal year ended June 30, 1919, required by the act of Congress approved March 3, 1887 (24 Stat., 523); and a statement showing travel on official business by officers and employees (other than special agents, inspectors, and employees who, in the discharge of their regular duties, are required to travel constantly) from Washington to points outside of the District of Columbia during the fiscal year ended June 30, 1919, as required by the act of Congress approved May 22, 1908 (35 Stat., 244), will be transmitted to Congress in the usual form.

The table following shows the total amount of all appropriations for the various bureaus and services of the Department of Commerce for the fiscal year ended June 30, 1919.

| Bureau. | Legislative act. | Sundry civil act. | Deficiency act. | Special act. | National security and defense. | Total. |
|---|---|---|---|---|---|---|
| Office of the Secretary | $327,540.00 | | | | $205,000.00 | $532,540.00 |
| Bureau of Lighthouses | 65,430.00 | $6,483,000.00 | $753,577.87 | $748,297.00 | 275,000.00 | 8,325,304.87 |
| Bureau of the Census | 1,349,240.00 | | 16.35 | | 160,000.00 | 1,509,256.35 |
| Bureau of Foreign and Domestic Commerce | 554,120.00 | | | | 325,000.00 | 879,120.00 |
| Steamboat-Inspection Service | 712,740.00 | | 143,934.17 | | | 856,674.17 |
| Bureau of Navigation | 217,045.00 | | | 736.65 | 40,000.00 | 257,781.65 |
| Bureau of Standards | 1,299,860.00 | 40,000.00 | 107,240.48 | 105,000.00 | 510,800.00 | 2,062,900.48 |
| Bureau of Fisheries | | 1,130,940.00 | 10,439.60 | | 160,000.00 | 1,301,379.60 |
| Coast and Geodetic Survey | | 1,364,960.00 | | | 47,104.56 | 1,412,064.56 |
| Total | 4,525,975.00 | 9,018,900.00 | 1,015,208.47 | 854,033.65 | 1,722,904.56 | 17,137,021.68 |
| Increase of compensation | 648,802.37 | | | | | 648,802.37 |
| Allotment for printing and binding | | 400,000.00 | | | | 400,000.00 |
| Grand total | 5,174,777.37 | 9,418,900.00 | 1,015,208.47 | 854,033.65 | 1,722,904.56 | 18,185,824.05 |

The disbursements by the authorized disbursing officers of the Department of Commerce during the fiscal year ended June 30, 1919, arranged according to items of appropriation, are as follows:

### *By Disbursing Clerk, Department of Commerce.*

#### OFFICE OF THE SECRETARY.

| | |
|---|---|
| Salaries, Office of the Secretary, 1918 | $7,388.15 |
| Salaries, Office of the Secretary, 1919 | 167,753.66 |
| Contingent expenses, Department of Commerce, 1917 | 3,098.20 |
| Contingent expenses, Department of Commerce, 1918 | 24,458.73 |
| Contingent expenses, Department of Commerce, 1919 | 86,288.03 |
| Rent, Department of Commerce, 1918 | 5,458.34 |
| Rent, Department of Commerce, 1919 | 61,404.16 |
| National security and defense, Industrial Board, 1919 | 5,334.49 |
| National security and defense, Industrial Cooperation Service, 1919 | 10,241.52 |
| National security and defense, waste-reclamation work, 1919 | 4,895.89 |
| Total | 376,321.17 |

#### BUREAU OF FOREIGN AND DOMESTIC COMMERCE.

| | |
|---|---|
| Promoting commerce, Department of Commerce, 1917 | 106.50 |
| Promoting commerce, Department of Commerce, 1918 | 3,707.51 |
| Promoting commerce, Department of Commerce, 1919 | 51,842.73 |
| Promoting commerce, South and Central America, 1918 | 4,342.15 |
| Promoting commerce, South and Central America, 1919 | 40,043.03 |
| Commercial attachés, Department of Commerce, 1918 | 922.68 |
| Commercial attachés, Department of Commerce, 1919 | 3,442.23 |
| Promoting commerce, Department of Commerce, Far East, 1919 | 7,791.67 |

| | |
|---|---|
| Salaries, Foreign and Domestic Commerce, 1918 | $5,959.96 |
| Salaries, Foreign and Domestic Commerce, 1919 | 127,773.07 |
| National security and defense, import and export statistics, 1918 | 1,767.35 |
| National security and defense, import and export statistics, 1919 | 59,194.31 |
| National security and defense, commodity experts, 1919 | 20,796.68 |
| National security and defense, special statistical work, 1919 | 10,803.80 |
| Total | 338,493.67 |

### BUREAU OF STANDARDS.

| | |
|---|---|
| Laboratory, Bureau of Standards | 278.81 |
| Chemical laboratory, Bureau of Standards | 302.35 |
| Radio laboratory | 28,592.69 |
| Equipping chemical laboratory, 1916–17 | 3,850.15 |
| Equipping chemical laboratory, 1917–18 | 10,175.09 |
| Salaries, 1918 | 13,456.82 |
| Salaries, 1919 | 343,167.46 |
| Equipment, 1917 | 4,997.28 |
| Equipment, 1918 | 10,426.13 |
| Equipment, 1919 | 58,374.46 |
| General expenses, 1917 | 304.65 |
| General expenses, 1918 | 6,289.73 |
| General expenses, 1919 | 17,343.40 |
| Improvement and care of grounds, 1917 | 486.37 |
| Improvement and care of grounds, 1918 | 1,183.29 |
| Improvement and care of grounds, 1919 | 4,672.18 |
| Testing railroad scales, 1917 | 8,588.35 |
| Testing railroad scales, 1918 | 11,321.11 |
| Testing railroad scales, 1919 | 35,220.83 |
| Testing structural material, 1917 | 86.74 |
| Testing structural materials, 1918 | 61,923.56 |
| Testing structural materials, 1919 | 212,166.50 |
| Testing machines, 1918 | 7,359.66 |
| Testing machines, 1919 | 26,314.13 |
| Investigation of fire-resisting properties, 1918 | 2,615.54 |
| Investigation of fire-resisting properties, 1919 | 21,057.38 |
| High-potential investigation, 1918 | 2,764.09 |
| High-potential investigation, 1919 | 11,429.08 |
| Investigation public utility standards, 1917 | .32 |
| Investigation public utility standards, 1918 | 4,244.22 |
| Investigation public utility standards, 1919 | 44,594.04 |
| Investigation public utility companies, 1918–19 | 38,813.98 |
| Investigation railway materials, 1917 | 100.25 |
| Investigation railway materials, 1918 | 3,959.02 |
| Investigation railway materials, 1919 | 12,053.25 |
| Testing miscellaneous materials, 1918 | 235.17 |
| Testing miscellaneous materials, 1919 | 24,706.35 |
| Radio research, 1917 | 6.57 |
| Radio research, 1918 | 1,455.50 |
| Radio research, 1919 | 18,763.23 |
| Investigation of clay products, 1918 | 2.00 |
| Investigation of clay products, 1919 | 16,329.91 |
| Determining physical constants, 1917 | 102.50 |

| | |
|---|---|
| Determining physical constants, 1918 | $406.99 |
| Determining physical constants, 1919 | 4,540.40 |
| Standardizing mechanical appliances, 1917 | 47.70 |
| Standardizing mechanical appliances, 1918 | 52.52 |
| Standardizing mechanical appliances, 1919 | 5,315.43 |
| Color standardization, 1917 | 827.99 |
| Color standardization, 1918 | 1,036.87 |
| Color standardization, 1919 | 8,143.04 |
| Investigation of optical glass, 1918 | 536.04 |
| Investigation of optical glass, 1919 | 70,213.74 |
| Gauge standardization, 1917–18 | 81,153.82 |
| Gauge standardization, 1919 | 367,291.84 |
| Military research, 1917–18 | 82,661.11 |
| Military research, 1918–19 | 510,211.49 |
| Investigation of mine scales and cars, 1918–19 | 10,796.17 |
| Repairs, power plant, 1918 | 1,995.55 |
| Standard materials, 1919 | 3,278.02 |
| Sugar standardization, 1919 | 15,731.47 |
| Investigation of textiles, 1919 | 6,407.06 |
| Renewal of storage batteries, 1919 | 2,575.09 |
| Industrial research, 1919–20 | 13,808.31 |
| Equipping laboratory, 1919–20 | 3,026.92 |
| Aviation, Navy, commerce transfer, 1919 | 4,177.14 |
| Armament of fortifications, commerce transfer | 58,872.71 |
| National security and defense, production of optical glass, 1918 | 23,645.93 |
| National security and defense, new building, 1918 | 18,145.51 |
| National security and defense, Roberts by-product coke oven, 1918 | 22,534.94 |
| National security and defense, metallurgical work, 1918 | 56,947.01 |
| National security and defense, industrial laboratory, 1918 | 642,279.89 |
| National security and defense, production of fabrics, 1918 | 24,577.48 |
| National security and defense, thermite investigation, 1918 | 729.29 |
| National security and defense, thermite investigation, 1919 | 3,454.25 |
| National security and defense, Roberts by-product coke oven, 1919 | 9,972.60 |
| National security and defense, altitude laboratory, 1919 | 59,897.19 |
| National security and defense, completing laboratory, 1919 | 169,327.32 |
| National security and defense, military researches, 1919 | 59,941.04 |
| National security and defense, industrial laboratory, 1919 | 34.86 |
| Total | 3,414,708.87 |

STEAMBOAT-INSPECTION SERVICE.

| | |
|---|---|
| Salaries, Office of Supervising Inspector General, 1918 | 742.52 |
| Salaries, Office of Supervising Inspector General, 1919 | 20,089.70 |
| Salaries, Steamboat-Inspection Service, 1918 | 34,322.88 |
| Salaries, Steamboat-Inspection Service, 1919 | 507,287.19 |
| Steamboat-Inspection Service, Tampa, Fla., 1918 | 505.50 |
| Clerk hire, Steamboat-Inspection Service, 1918 | 7,757.35 |
| Clerk hire, Steamboat-Inspection Service, 1919 | 97,057.25 |
| Contingent expenses, Steamboat-Inspection Service, 1917 | 6.00 |
| Contingent expenses, Steamboat-Inspection Service, 1918 | 24,996.18 |
| Contingent expenses, Steamboat-Inspection Service, 1919 | 112,271.40 |
| Total | 805,035.97 |

### BUREAU OF NAVIGATION.

| | |
|---|---|
| Salaries, Bureau of Navigation, 1918 | $1,578.81 |
| Salaries, Bureau of Navigation, 1919 | 33,919.71 |
| Salaries, Shipping Service, 1918 | 2,333.01 |
| Salaries, Shipping Service, 1919 | 26,232.64 |
| Clerk hire, Shipping Service, 1918 | 3,919.39 |
| Clerk hire, Shipping Service, 1919 | 42,495.27 |
| Contingent expenses, Shipping Service, 1918 | 1,341.27 |
| Contingent expenses, Shipping Service, 1919 | 5,475.00 |
| Enforcement navigation laws, 1917 | 150.00 |
| Enforcement navigation laws, 1918 | 5,368.24 |
| Enforcement navigation laws, 1919 | 24,067.78 |
| Enforcement wireless-communication laws, 1918 | 9,646.13 |
| Enforcement wireless-communication laws, 1919 | 38,198.26 |
| Preventing overcrowding of passenger vessels, 1917 | 2.00 |
| Preventing overcrowding of passenger vessels, 1918 | 2,478.61 |
| Preventing overcrowding of passenger vessels, 1919 | 15,413.08 |
| Admeasurement of vessels, 1918 | 910.22 |
| Admeasurement of vessels, 1919 | 1,972.70 |
| Total | 215,502.12 |

### BUREAU OF FISHERIES.

| | |
|---|---|
| Fish hatchery, Bozeman, Mont | 9.94 |
| Fish hatchery, Cape Vincent, N. Y., 1918 | 4,385.29 |
| Fish hatchery, Edenton, N. C., 1918 | 2,500.00 |
| Fish hatchery, Puget Sound, Wash | 690.14 |
| Fish hatchery, S. C | 245.85 |
| Fish hatchery, Wyo | 1,469.50 |
| Fish hatchery, Cold Spring, Ga | 107.10 |
| Fish hatchery, St. Johnsbury, Vt | 10.00 |
| Fish hatchery, Rhode Island | 40.86 |
| Trout hatchery, Berkshire, Mass | 1,608.70 |
| Marine biological station, Florida | 1,922.66 |
| Biological station, Mississippi River Valley | 2,048.74 |
| Repairs, steamer *Fish Hawk*, 1918 | 33,442.00 |
| Building and improvements, fur-seal islands, Alaska | 2,320.05 |
| Investigating damages to fisheries | 671.83 |
| Salaries, Bureau of Fisheries, 1918 | 25,812.32 |
| Salaries, Bureau of Fisheries, 1919 | 342,567.59 |
| Miscellaneous expenses, 1917 | 320.92 |
| Miscellaneous expenses, 1918 | 69,293.90 |
| Miscellaneous expenses, 1919 | 437,152.79 |
| Protecting seal and salmon fisheries of Alaska, 1918 | 6,327.04 |
| Protecting seal and salmon fisheries of Alaska, 1919 | 100,280.19 |
| Developing aquatic sources of leather, 1917–18 | 1,554.33 |
| Power lighter, fur-seal islands, Alaska | 38.31 |
| National security and defense, food-fish supply, 1918 | 5,442.97 |
| National security and defense, food-fish supply, 1919 | 30,286.17 |
| National security and defense, rescuing food fish, 1918 | 7,548.60 |
| National security and defense, seal-oil plant, 1918 | 19,706.01 |
| National security and defense, demonstration plant, 1919 | 83,760.71 |
| Total | 1,181,564.51 |

### BUREAU OF THE CENSUS.

| | |
|---|---|
| Salaries, 1918 | $27,283.24 |
| Salaries, 1919 | 623,406.16 |
| Collecting statistics, 1917 | 63.45 |
| Collecting statistics, 1918 | 45,418.07 |
| Collecting statistics, 1919 | 433,665.90 |
| Tabulating machines, 1918 | 13,614.33 |
| Tabulating machines, 1919 | 32,444.86 |
| Uniform nomenclature, 1919 | 6,293.17 |
| National security and defense, special statistical work, 1919 | 124,725.43 |
| Total | 1,306,914.61 |

### BUREAU OF LIGHTHOUSES.

| | |
|---|---|
| Aids to navigation, Alaska | 7.03 |
| Aids to navigation, Lorain Harbor, Ohio | 61.37 |
| Light station, Navassa Island, West Indies | 135.06 |
| Light station, Sand Hills, Mich | 15,719.39 |
| Aids to navigation, Fighting Island Channel, Detroit River, Mich. | 101.22 |
| Aids to navigation, Delaware River, Pa. and Del | 8,183.30 |
| Aids to navigation, Wash. and Oreg | 2.16 |
| Light vessels for general service | 75,790.22 |
| General expenses, Lighthouse Service, 1917 | 209.11 |
| General expenses, Lighthouse Service, 1918 | 44,286.43 |
| General expenses, Lighthouse Service, 1919 | 49,360.49 |
| Salaries, Bureau of Lighthouses, 1918 | 2,792.98 |
| Salaries, Bureau of Lighthouses, 1919 | 53,839.12 |
| Salaries, Lighthouse Service, 1918 | 202.50 |
| Salaries, Lighthouse Service, 1919 | 6,296.00 |
| Tender, third lighthouse district | 5.40 |
| Tender for engineer, sixth lighthouse district | 3.91 |
| Repairs and rebuilding aids to navigation, Gulf of Mexico | 98.40 |
| Repairing and rebuilding aids to navigation, Atlantic coast | 20.58 |
| Lighthouse depot, Detroit, Mich | 7,432.03 |
| Nantucket Harbor Fog-Signal Station, Mass | 4.50 |
| Point Boringuen Light Station, P. R | 13.20 |
| Salaries, lighthouse vessels, 1919 | 16,391.14 |
| Salaries, keepers of lighthouses, 1919 | 4,008.78 |
| Fifth lighthouse district, gas buoys | 40.61 |
| Joe Flogger Shoal Light Station, Delaware River | 6.04 |
| National security and defense, aids to navigation, Caribbean Sea, 1919 | 23.15 |
| Total | 285,034.12 |

### MISCELLANEOUS.

| | |
|---|---|
| Increase of compensation, Department of Commerce, 1918 | 8,117.76 |
| Increase of compensation, Department of Commerce, 1919 | 234,238.19 |
| Total | 242,355.95 |
| Grand total | 8,165,930.99 |

*By disbursing officers of the Lighthouse Service.*

| | |
|---|---|
| Repairing and rebuilding aids to navigation, Atlantic coast | $124, 289. 30 |
| Light vessels for general service | 3, 442. 53 |
| Oilhouses for light stations | 464. 03 |
| Dog Island Light, Me | 2, 718. 20 |
| Woods Hole Lighthouse Depot, Mass | 1, 270. 21 |
| Nantucket Harbor Fog Signal, Mass | 5, 012. 34 |
| Staten Island lighthouse depot, N. Y | 50, 624. 40 |
| Aids to navigation, Hudson River, N. Y | 77, 492. 06 |
| Aids to navigation, East River, N. Y | 6, 603. 18 |
| Great Salt Pond Light Station, R. I | 16. 62 |
| Aids to navigation, Delaware River, Pa. and Del | 1, 065. 81 |
| Joe Flogger Shoal Light Station, Delaware River | 7, 920. 00 |
| Thimble Shoal Light Station, Va | 725. 00 |
| Aids to navigation, Cape Charles City, Va | 3, 524. 00 |
| Aids to navigation, Chesapeake Bay, Md. and Va | 1, 201. 80 |
| Fifth lighthouse district gas buoys | 39, 093. 37 |
| Tender for engineer, sixth lighthouse district | 552. 79 |
| Aids to navigation, St. Johns River, Fla | 7, 171. 97 |
| Galveston Jetty Light Station, Tex | 315. 00 |
| Aids to navigation, Mississippi River, La | 18, 090. 50 |
| Aids to navigation, Atchafalaya Entrance, La | 4, 132. 92 |
| Repairing and rebuilding aids to navigation, Gulf of Mexico | 62, 834. 59 |
| Aransas Pass Light Station, Tex | 10, 445. 20 |
| Navassa Island Light Station, West Indies | 151. 62 |
| Point Boringuen Light Station, P. R | 488. 13 |
| Aids to navigation, Ashtabula Harbor, Ohio | 550. 20 |
| Aids to navigation, Lorain Harbor, Ohio | 2, 469. 46 |
| Aids to navigation, Conneaut Harbor, Ohio | 18, 309. 04 |
| Aids to navigation, Toledo Harbor, Ohio | 321. 41 |
| Aids to navigation, Huron Harbor, Ohio | 3, 509. 70 |
| Aids to navigation, Fairport Harbor, Ohio | 995. 00 |
| Superior Pierhead Range Lights, Wis | 1, 837. 00 |
| Detroit River Lights, Mich | 13. 70 |
| Aids to navigation, Fighting Island Channel, Detroit River, Mich | 4, 639. 54 |
| Sand Hills Light Station, Mich | 34, 253. 26 |
| Aids to navigation, Keeweenaw Waterway, Mich | 51, 319. 61 |
| Detroit Lighthouse Depot, Mich | 7, 447. 04 |
| Aids to navigation, St. Marys Island, Mich | 640. 06 |
| White Shoal Light Station, Mich | 545. 55 |
| Chicago Harbor Light Station, Ill | 31, 957. 44 |
| Manitowoc Breakwater Light Station, Wis | 19, 859. 30 |
| Aids to navigation, Alaska | 8, 127. 00 |
| Cape St. Elias Light Station, Alaska | 103. 20 |
| Depot for sixteenth lighthouse district | 48, 589. 95 |
| Aids to navigation, Puget Sound, Wash | 783. 83 |
| Kellett Bluff Light Station, Wash | 35, 028. 75 |
| Aids to navigation, Wash. and Oreg | 15, 671. 99 |
| Aids to navigation, Pearl Harbor, Hawaii | 7, 741. 91 |
| National security and defense, lighthouse depot, Tompkinsville, N. Y., 1919 | 15, 261. 96 |
| National security and defense, aids to navigation, Caribbean Sea, 1919 | 12, 658. 56 |
| General expenses, Lighthouse Service, 1917 | 59, 789. 95 |

| | |
|---|---|
| General expenses, Lighthouse Service, 1918 | $633,310.97 |
| General expenses, Lighthouse Service, 1919 | 2,436,730.08 |
| Salaries, keepers of lighthouses, 1918 | 26,192.88 |
| Salaries, keepers of lighthouses, 1919 | 1,109,101.76 |
| Salaries, lighthouse vessels, 1918 | 53,889.07 |
| Salaries, lighthouse vessels, 1919 | 1,332,539.92 |
| Salaries, Lighthouse Service, 1918 | 3,925.88 |
| Salaries, Lighthouse Service, 1919 | 363,520.43 |
| Increase of compensation, Department of Commerce, 1918 | 7,851.10 |
| Increase of compensation, Department of Commerce, 1919 | 365,418.62 |
| Retired pay, Lighthouse Service, 1919 | 20,987.65 |
| Total | 7,165,538.34 |

*By special disbursing agent, Coast and Geodetic Survey.*

| | |
|---|---|
| Salaries, Coast and Geodetic Survey, 1918 | $9,671.23 |
| Salaries, Coast and Geodetic Survey, 1919 | 363,471.97 |
| Party expenses, Coast and Geodetic Survey, 1917 | 182.15 |
| Party expenses, Coast and Geodetic Survey, 1918 | 64,173.64 |
| Party expenses, Coast and Geodetic Survey, 1919 | 266,740.65 |
| Party expenses, Coast and Geodetic Survey | 476.45 |
| Repairs of vessels, Coast and Geodetic Survey, 1918 | 763.11 |
| Repairs of vessels, Coast and Geodetic Survey, 1919 | 8,307.09 |
| General expenses, Coast and Geodetic Survey, 1917 | 44.54 |
| General expenses, Coast and Geodetic Survey, 1918 | 25,258.11 |
| General expenses, Coast and Geodetic Survey, 1919 | 70,835.82 |
| Pay, etc., of officers and men, vessels, Coast and Geodetic Survey, 1917 | 50.00 |
| Pay, etc., of officers and men, vessels, Coast and Geodetic Survey, 1918 | 20,663.34 |
| Pay, etc., of officers and men, vessels, Coast and Geodetic Survey, 1919 | 105,344.83 |
| Charts, Coast and Geodetic Survey, 1917–18 | 1,253.02 |
| Two new vessels, Coast and Geodetic Survey | .98 |
| Increase of compensation, Department of Commerce, 1918 | 1,939.50 |
| Increase of compensation, Department of Commerce, 1919 | 29,942.41 |
| National security and defense, Department of Commerce, Coast and Geodetic Survey, new building | 84,991.42 |
| National security and defense, Department of Commerce, Coast and Geodetic Survey, new building, 1919 | 2,967.45 |
| National security and defense, Department of Commerce, Coast and Geodetic Survey, printing press, 1919 | 11,646.96 |
| National security and defense, Department of Commerce, Coast and Geodetic Survey, building equipment, 1919 | 6,849.56 |
| Motor-driven vessel and launches, 1919 | 40,631.79 |
| Total | 1,116,206.02 |

*By special disbursing agents, Bureau of Fisheries.*

| | |
|---|---|
| Miscellaneous expenses, Bureau of Fisheries, 1919 | $24,691.92 |
| Pay, officers and crews of vessels, Alaska Fisheries Service, 1919 | 23,725.45 |
| Protecting seal and salmon fisheries of Alaska, 1919 | 1,710.00 |
| Marine biological station, Fla. | 68.24 |
| Increase of compensation, Department of Commerce, 1919 | 1,000.00 |
| Total | 51,195.61 |

*By the commercial agents investigating trade conditions abroad, Department of Commerce, acting as special disbursing agents.*

| | |
|---|---|
| Commercial attachés, Department of Commerce, 1918 | $6,227.67 |
| Commercial attachés, Department of Commerce, 1919 | 111,398.65 |
| National security and defense, Department of Commerce: | |
| Commodity experts, 1919 | 88,525.80 |
| Import and export statistics, 1919 | 2,556.00 |
| Promoting commerce, South and Central America, 1919 | 44,600.15 |
| Promoting commerce, Department of Commerce, 1918 | 609.03 |
| Promoting commerce, Department of Commerce, 1919 | 39,410.78 |
| Promoting commerce, Far East, 1919 | 28,915.49 |
| Increase of compensation, Department of Commerce, 1918 | 18.76 |
| Increase of compensation, Department of Commerce, 1919 | 46.25 |
| Total | 322,308.58 |

Warrants drawn on the Treasurer of the United States to satisfy accounts settled by the Auditor for the State and Other Departments, during the fiscal year ended June 30, 1919, classified according to items of appropriation:

| | |
|---|---|
| Office of the Secretary: | |
| Contingent expenses, Department of Commerce, 1917 | $70.68 |
| Contingent expenses, Department of Commerce, 1918 | 186.57 |
| Contingent expenses, Department of Commerce, 1919 | 4,704.33 |
| Increase of compensation, 1918 | 7.50 |
| Increase of compensation, 1919 | 75.67 |
| National security and defense, Industrial Board, 1919 | 5,637.34 |
| National security and defense, Industrial Cooperation Service, 1919 | 963.52 |
| National security and defense, waste-reclamation work, 1919 | 820.24 |
| Total | 12,465.85 |
| Bureau of Foreign and Domestic Commerce: | |
| Commercial attachés, 1918 | 134.41 |
| Promoting commerce, 1918 | 171.46 |
| Promoting commerce, 1919 | 86.90 |
| Promoting commerce, South and Central America, 1918 | 37.87 |
| Promoting commerce, South and Central America, 1919 | 14.84 |
| National security and defense, import and export statistics, 1919 | 1,331.98 |
| National security and defense, commodity experts, 1919 | 9.00 |
| Total | 1,786.46 |
| Bureau of Standards: | |
| Equipment, 1917 | 328.76 |
| Equipment, 1918 | 14.17 |
| Equipment, 1919 | 623.83 |
| Gauge standardization, 1919 | 7,712.56 |
| General expenses, 1918 | 75.33 |
| General expenses, 1919 | 5,815.95 |
| High-potential investigation, 1919 | 41.80 |
| Investigation of public utility standards, 1919 | 403.66 |
| Investigation of railway materials, 1918 | 36.68 |

| | |
|---|---|
| Bureau of Standards—Continued. | |
| Military research, 1917–18 | $2,657.32 |
| Military research, 1918–19 | 1,055.52 |
| Investigation of optical glass, 1918 | 121.00 |
| Investigation of public utility companies, 1918–19 | 44.90 |
| Standard materials, 1919 | 53.89 |
| Sugar standardization, 1919 | 16.11 |
| Radio research, 1917 | 14.45 |
| Salaries, 1919 | 42.22 |
| Standardizing mechanical appliances, 1919 | 42.65 |
| Testing machines, 1919 | 59.10 |
| Testing structural materials, 1918 | 161.46 |
| Testing structural materials, 1919 | 94.41 |
| National security and defense, metallurgical work | 42.00 |
| National security and defense, new building | 97.47 |
| National security and defense, production of optical glass | 3.60 |
| National security and defense, completing laboratory, 1919 | 2,595.95 |
| National security and defense, military researches, 1919 | 589.09 |
| Certified claims— | |
| Testing structural materials, 1912 | 2.05 |
| Investigation of railway materials, 1915 | 110.00 |
| Equipment, 1916 | 114.00 |
| General expenses, 1916 | 1.21 |
| Testing railroad scales, 1916 | 6.00 |
| Total | 22,977.14 |
| Bureau of Navigation: | |
| Refunding penalties or charges erroneously exacted | 721.63 |
| Contingent expenses, Shipping Service, 1917 | 1.94 |
| Contingent expenses, Shipping Service, 1918 | 10.65 |
| Contingent expenses, Shipping Service, 1919 | 1.07 |
| Enforcement of wireless-communication laws, 1917 | 2.05 |
| Enforcement of wireless-communication laws, 1918 | 3.93 |
| Enforcement of wireless-communication laws, 1919 | 1.35 |
| Total | 742.62 |
| Steamboat-Inspection Service: | |
| Clerk hire, 1919 | 566.67 |
| Contingent expenses, 1917 | 40.17 |
| Contingent expenses, 1918 | 200.86 |
| Contingent expenses, 1919 | 354.46 |
| Salaries, 1919 | 1,111.94 |
| Steamboat-Inspection Service, Tampa, Fla., 1918 | 23.08 |
| Certified claims—Contingent expenses, 1916 | 1.52 |
| Total | 2,298.70 |
| Bureau of Fisheries: | |
| Building and improvements, fur-seal islands, Alaska | 219.37 |
| Miscellaneous expenses, 1917 | 148.97 |
| Miscellaneous expenses, 1918 | 486.70 |
| Miscellaneous expenses, 1919 | 1,115.31 |
| Protecting seal and salmon fisheries of Alaska, 1917 | 2.02 |
| Protecting seal and salmon fisheries of Alaska, 1918 | 282.81 |

| | |
|---|---|
| Bureau of Fisheries—Continued. | |
| Salaries, 1919 | $50.00 |
| Repairs to steamer *Fish Hawk*, 1918 | 340.59 |
| National security and defense, food-fish supply, 1918 | 4.37 |
| National security and defense, seal-oil plant | 38.16 |
| Certified claims— | |
| Miscellaneous expenses, 1905 | .88 |
| Miscellaneous expenses, 1908 | .70 |
| Miscellaneous expenses, 1909 | 4.11 |
| Miscellaneous expenses, 1910 | 2.82 |
| Miscellaneous expenses, 1911 | 1.74 |
| Miscellaneous expenses, 1912 | 4.97 |
| Miscellaneous expenses, 1916 | .31 |
| Total | 2,703.83 |
| Bureau of the Census: | |
| Collecting statistics, 1918 | 97.25 |
| Collecting statistics, 1919 | 14.42 |
| Salaries, 1919 | 35.00 |
| Relief of Alice V. Houghton for injuries | 900.00 |
| Total | 1,046.67 |
| Coast and Geodetic Survey: | |
| General expenses, 1917 | 34.60 |
| General expenses, 1918 | 175.74 |
| General expenses, 1919 | 1,439.14 |
| Party expenses, 1917 | 78.10 |
| Party expenses, 1918 | 6,434.58 |
| Party expenses, 1919 | 1,184.83 |
| Repairs of vessels, 1918 | 12,111.91 |
| Salaries, 1919 | 3.37 |
| Total | 21,462.27 |
| Bureau of Lighthouses: | |
| Aids to navigation, Alaska | 317.56 |
| Aids to navigation, Washington and Oregon | 80.05 |
| Lighthouse tender for general service | 250.07 |
| Radio installation for lighthouse tender | 281.87 |
| Repairing and rebuilding aids to navigation, Atlantic coast | 1.94 |
| Tender for engineer, sixth lighthouse district | 5.98 |
| General expenses, 1917 | 6,447.10 |
| General expenses, 1918 | 25,481.59 |
| General expenses, 1919 | 64,534.85 |
| Salaries, Lighthouse Service, 1918 | 4.00 |
| Salaries, Lighthouse vessels, 1918 | 1,727.50 |
| Certified claims— | |
| General expenses, Lighthouse Service, 1915 | 174.37 |
| General expenses, Lighthouse Service, 1916 | 2,579.80 |
| Total | 101,886.68 |
| Miscellaneous: Judgments, Court of Claims, Department of Commerce | 3,378.66 |
| Grand total | 170,748.88 |

The following statement shows the expenditures during the fiscal year ended June 30, 1919, on account of all appropriations under the control of the Department, giving the total amounts disbursed by the various disbursing officers of the Department, and miscellaneous receipts for the same period:

### EXPENDITURES.

| | |
|---|---|
| By the Disbursing Clerk, Department of Commerce, on account of salaries and expenses of the Office of the Secretary of Commerce, the Bureaus of Foreign and Domestic Commerce, Navigation, Standards, Fisheries, the Census, and Lighthouses, the office of the Supervising Inspector General, Steamboat-Inspection Service, salaries and expenses of the Steamboat-Inspection Service at large, and public works of the Lighthouse and Fisheries Services (shown in detail in the first of the foregoing tables of disbursements) | $8,165,930.99 |
| By the authorized disbursing officers of the Lighthouse Service | 7,165,538.34 |
| By the special disbursing agent, Coast and Geodetic Survey | 1,116,206.02 |
| By special disbursing agents, Bureau of Fisheries | 51,195.61 |
| By the commercial agents of the Department investigating trade conditions abroad, as special disbursing agents | 322,308.58 |
| By warrants drawn on the Treasurer of the United States to satisfy accounts settled by the Auditor for the State and Other Departments | 170,748.88 |
| Printing and binding | 399,961.32 |
| Total | 17,391,889.74 |

### MISCELLANEOUS RECEIPTS.

| | |
|---|---|
| Coast and Geodetic Survey: Sale of charts, publications, old property, etc | 24,052.10 |
| Bureau of the Census: Sale of publications, etc | 282.00 |
| Bureau of Fisheries: | |
| Sale of 18,223 sealskins | 741,197.42 |
| Sale of fox and other skins | 67,588.33 |
| Sale of seal bones | 2,752.80 |
| Sale of old property, etc | 11,615.66 |
| Bureau of Navigation: | |
| Tonnage tax | 1,265,229.23 |
| Navigation fees | 143,492.19 |
| Navigation fines | 162,146.50 |
| From deceased passengers | 460.00 |
| Bureau of Standards: Sale of old property, etc | 12.50 |
| Steamboat-Inspection Service: Sale of old property, etc | 31.55 |
| Bureau of Lighthouses: Sale of old property, rentals, etc | 35,372.69 |
| Office of the Secretary: Sale of old property, etc | 1,054.58 |
| Total | 2,455,287.55 |

The following unexpended balances of appropriations were turned in to the surplus fund June 30, 1919, in accordance with the act of June 20, 1874 (18 Stat., 110–111):

| | |
|---|---|
| Office of the Secretary: | |
| Salaries, Office of Secretary of Commerce, 1917 | $2, 314. 05 |
| Increase of compensation, Department of Commerce, 1918 | 13, 429. 68 |
| Contingent expenses, Department of Commerce, 1917 | 3. 02 |
| Bureau of the Census: | |
| Salaries, Bureau of the Census, 1917 | 15, 387. 92 |
| Collecting statistics, Bureau of the Census, 1917 | 106, 140. 43 |
| Tabulating machines, Bureau of the Census, 1917 | 495. 74 |
| Bureau of Foreign and Domestic Commerce: | |
| Salaries, Bureau of Foreign and Domestic Commerce, 1917 | 4, 155. 25 |
| Commercial attachés, Department of Commerce, 1915 | 342. 75 |
| Commercial attachés, Department of Commerce, 1916 | 483. 03 |
| Commercial attachés, Department of Commerce, 1917 | 3, 365. 62 |
| Promoting commerce, Department of Commerce, 1917 | 2, 853. 02 |
| Promoting commerce, South and Central America, 1917 | 3, 799. 83 |
| Investigating cost of production, Department of Commerce, 1917 | 15, 075. 30 |
| Steamboat-Inspection Service: | |
| Salaries, Office of Supervising Inspector General, Steamboat-Inspection Service, 1917 | 18. 97 |
| Salaries, Steamboat-Inspection Service, 1917 | 4, 219. 95 |
| Clerk hire, Steamboat-Inspection Service, 1917 | 577. 59 |
| Contingent expenses, Steamboat-Inspection Service, 1917 | 4, 597. 25 |
| Bureau of Navigation: | |
| Salaries, Bureau of Navigation, 1917 | 411. 97 |
| Salaries, Shipping Service, 1917 | 763. 67 |
| Clerk hire, Shipping Service, 1917 | 24. 50 |
| Contingent expenses, Shipping Service, 1917 | 7. 97 |
| Admeasurement of vessels, 1917 | 15. 90 |
| Preventing overcrowding of passenger vessels, 1917 | 1, 162. 24 |
| Enforcement of navigation laws, 1917 | 20. 10 |
| Enforcement of wireless-communication laws, 1917 | 2, 831. 68 |
| Bureau of Standards: | |
| Salaries, 1917 | 21, 978. 87 |
| Equipment, 1917 | 815. 13 |
| General expenses, 1917 | 522. 22 |
| Improvement and care of grounds, 1917 | 64. 33 |
| Color standardization, 1917 | 272. 66 |
| Determining physical constants, 1917 | 528. 38 |
| Equipping chemical laboratory building, 1916–17 | 327. 24 |
| Investigation of clay products, 1917 | 26. 61 |
| Investigation of fire-resisting properties, 1917 | 78. 41 |
| High-potential investigations, 1917 | 125. 17 |
| Investigation of public utility standards, 1917 | 297. 56 |
| Investigation of railway materials, 1917 | 106. 34 |
| Radio research, 1917 | 756. 40 |
| Refrigeration constants, 1917 | 57. 74 |
| Standardizing mechanical appliances, 1917 | 468. 38 |
| Testing machines, 1917 | 283. 73 |
| Testing miscellaneous materials, 1917 | 107. 08 |
| Testing railroad scales, etc., 1917 | 189. 63 |
| Testing structural materials, 1917 | 898. 68 |

| | |
|---|---|
| Coast and Geodetic: | |
| Salaries, 1917 | $5,196.86 |
| Party expenses, 1916 | 38.15 |
| Party expenses, 1917 | 12,945.04 |
| General expenses, 1917 | 63.37 |
| Pay, etc., officers and men, vessels, Coast Survey, 1917 | 24,321.88 |
| Repairs of vessels, Coast Survey, 1917 | 1,794.95 |
| Outfitting Coast Survey steamer *Surveyor*, 1917 | 626.04 |
| Bureau of Lighthouses: | |
| Salaries, Bureau of Lighthouses, 1917 | 2,619.63 |
| General expenses, Lighthouse Service, 1916 | 14,275.09 |
| General expenses, Lighthouse Service, 1917 | 30,592.40 |
| Salaries, keepers of lighthouses, 1917 | 8,046.02 |
| Salaries, lighthouse vessels, 1917 | 105,311.62 |
| Salaries, Lighthouse Service, 1917 | 6,825.53 |
| Staten Island and West Bank Light Station, N. Y | 26,027.36 |
| Newark Bay beacon lights, N. J | 7.19 |
| Cleveland Fog Signal Station, Ohio | 26.37 |
| Bureau of Fisheries: | |
| Salaries, Bureau of Fisheries, 1917 | 18,913.70 |
| Miscellaneous expenses, Bureau of Fisheries, 1917 | 4,792.13 |
| Motor launches, Alaska fisheries service, 1917 | 31.26 |
| Pay, officers and crew of vessel, Alaska fisheries service, 1917 | 26.24 |
| Protecting seal and salmon fisheries of Alaska, 1917 | 170.18 |
| Fish hatchery, Gloucester, Mass., 1917 | 2,981.85 |
| Steamer *Albatross*, repairs, 1917 | 3.25 |
| Reimbursement to officers and crew of lighthouse tender *Manzanita* | 7.00 |
| Total | 476,045.10 |

In the last seven years the Department of Commerce has turned back unused into the Treasury the following amounts:

| | |
|---|---|
| June 30, 1913 | $618,970.01 |
| June 30, 1914 | 347,162.48 |
| June 30, 1915 | 247,482.22 |
| June 30, 1916 | 227,941.92 |
| June 30, 1917 | 177,995.27 |
| June 30, 1918 | $149,009.51 |
| June 30, 1919 | 476,045.10 |
| Total | 2,244,606.51 |

There is a general impression that money appropriated means money spent. Yet here is a total of $2,244,606.51 which could have been expended for the purposes named, but was not. In business circles such action would be deemed commendable and would win confidence of financial authorities in the wisdom of the disbursing organization. The reverse is true, however, in the Government under the existing system. The inference is not drawn from such facts by appropriating committees that care has been used in expenditure and so something has been saved for the Government, but rather that the estimates were, in the first instance, extravagant and blameworthy. Almost the first question asked when considering estimates is what the unexpended balance was the previous year, and it is argued that if last year a considerable balance remained less is needed for the coming year. The very economy resulting in the balance saved is made the basis for mulcting a service on its necessary expenditures in the future.

This is here pointed out as one of the faults, minor but real, of the present system of appropriating funds for Government purposes which it may be hoped a modern budget system would remove. When the writer was an officer of the City of New York a direct incentive to saving was provided by the city charter which permitted unexpended balances to be used under the authority of the board of estimate for other work. Under such a system an executive naturally saved all he could in order to do as much work as possible with what remained. Under the present Government system the temptation is direct to use as nearly as possible all of the appropriation lest one be mulcted in the coming year and have insufficient funds for necessary work.

### Estimates for Fiscal Year Ending June 30, 1921.

The estimates for the fiscal year 1921 aggregate $35,318,068.40, and exceed the appropriations for the fiscal year 1920, amounting to $29,052,955, by $6,265,113.40.

The estimates include an item for the Fourteenth Decennial Census amounting to $6,215,000.

The estimate is submitted in this form in view of the fact that it is impossible to apportion, with any approach to accuracy, the cost of the work during the second year of the decennial census period.

As the legislative, executive, and judicial act, approved March 1, 1919, carries an appropriation of $15,000,000 for Fourteenth Census work, this will make a total of $21,215,000 required for the Fourteenth Decennial Census period.

The total amount requested in last year's estimate for the Fourteenth Census period was $20,500,000, or $715,000 less than the total amount now estimated. This is accounted for as follows:

Since the original estimate was prepared, provision for an additional inquiry, relating to encumbrances on homes, was inserted in the census bill by the Senate and was enacted into law. The inclusion of this inquiry will add approximately $1,000,000 to the cost of the Fourteenth Census. An additional estimate of $50,000 has been made necessary for the construction of a fireproof vault installation of freight elevators, the strengthening of floors, etc., at the temporary war building, which has been assigned to the bureau for the use of the Fourteenth Census force.

The original estimate of $300,000 for rent of buildings in the District of Columbia, and $35,000 for fuel contained in last year's estimates, have been eliminated on account of the assignment to this bureau of the temporary war building. The cost of heating that building will be paid by the Office of the Superintendent of the State, War, and Navy Building.

These changes are equivalent to a net increase of $715,000.

The estimates submitted by the Lighthouse Service show an increase over appropriations of $9,329,338.40. They include items of public works approximating $8,000,000, of which items amounting to $1,500,000 have been heretofore authorized by Congress. Fourteen items amounting to $6,375,750 have not yet been authorized, but are urgently needed for the Service.

The increase for the Bureau of Foreign and Domestic Commerce is $747,910, of which $117,410 is for salaries for additional employees in Washington to enable the bureau to keep abreast of the ever-increasing work and $410,000 additional is needed for the field service in this country and abroad. Sixty-nine thousand dollars is required for the development of trade by motion pictures, and $151,500 is asked for post allowances for men in foreign service, for transporting their families, and for bringing home the remains of such as may die abroad.

The Steamboat-Inspection Service submits estimates increasing the amount appropriated for 1920 by $97,320, as the Service is being called on continually to do more work incident to the country's shipping program.

The increase for the Bureau of Navigation is $174,204 to enable the bureau to take care of the ever-increasing shipping problems which by law are imposed on this bureau.

The war added many new investigations to the Bureau of Standards, the cost of which during the war was borne by other departments and the President's fund, and approximately $2,000,000 additional is required to enable the bureau to pursue these investigations, which will result in great benefit to the Government and general public in peace times.

The Bureau of Fisheries asks $637,880 additional, and the Coast and Geodetic Survey submits estimates which exceed the appropriations for 1920 by $2,000,000, over $1,000,000 of which is required for new vessels.

Increases of salaries for employees in the District of Columbia are not included in the recommendations of this Department because the matter is under consideration by the Joint Commission on Reclassification of Salaries, and request will be made in the Book of Estimates that appropriations for these salaries be adjusted in accordance with such recommendations of the commission as receive the approval of the Congress.

This Department desires that such recommendations for increased salaries as may be recommended by the Joint Commission on Reclassification of Salaries be considered in connection with the estimates of this Department.

COMPARISON OF THE ITEMS OF ESTIMATES FOR THE DEPARTMENT OF COMMERCE SUBMITTED FOR THE FISCAL YEAR 1921 WITH THE APPROPRIATIONS ACTUALLY MADE BY THE CONGRESS FOR THE FISCAL YEAR 1920.

| | Estimates, 1921. | Appropriations, 1920. | Increase. | Decrease. |
|---|---|---|---|---|
| OFFICE OF THE SECRETARY. | | | | |
| Salaries | $214,950.00 | $196,050.00 | $18,900.00 | |
| Contingent expenses | 60,000.00 | 50,000.00 | 10,000.00 | |
| Rent | 68,500.00 | 68,500.00 | | |
| Total | 343,450.00 | 314,550.00 | 28,900.00 | |
| LIGHTHOUSE SERVICE. | | | | |
| Salaries | 79,668.40 | 65,430.00 | 14,238.40 | |
| General expenses | 4,300,000.00 | 3,500,000.00 | 800,000.00 | |
| Salaries of keepers | 1,330,000.00 | 1,300,000.00 | 30,000.00 | |
| Salaries, light vessels | 2,100,000.00 | 1,400,000.00 | 700,000.00 | |
| Salaries, Lighthouse Service | 490,000.00 | 380,000.00 | 110,000.00 | |
| Retired pay, Lighthouse Service | 85,000.00 | 45,000 00 | 40,000 00 | |
| Public works: | | | | |
| Tenders and light vessels | 5,000,000.00 | | 5,000,000.00 | |
| Lighthouse tenders and light vessels | 760,000.00 | | 760,000.00 | |
| Diamond Shoal Light Vessel | 450,000.00 | | 450,000.00 | |
| Hawaiian Island lighthouse depot | 120,000.00 | | 120,000.00 | |
| Fifth lighthouse district depot | 350,000.00 | | 350,000.00 | |
| Virgin Islands, aids to navigation | 50,000.00 | | 50,000.00 | |
| Potomac River, aids to navigation | 95,000.00 | | 95,000.00 | |
| Eighth lighthouse district depot | 132,750.00 | | 132,750.00 | |
| Charleston, S. C., depot | 60,000.00 | | 60,000.00 | |
| Seventh lighthouse district depot | 250,000.00 | | 250,000.00 | |
| Conneaut Harbor, Ohio, aids to navigation | 19,600.00 | | 19,600.00 | |
| Ludington, Mich., aids to navigation | 75,000.00 | | 75,000.00 | |
| Tampa Bay, aids to navigation | 17,500.00 | | 17,500.00 | |
| Delaware Bay Entrance, aids to navigation | 148,500.00 | | 148,500.00 | |
| Newport, R. I., lighthouse depot | 82,300.00 | | 82,300.00 | |
| California and Nevada, aids to navigation | 44,750.00 | | 44,750.00 | |
| Depot keepers' dwellings | 18,000.00 | | 18,000.00 | |
| Cape Spencer, Alaska, Lighthouse Service | 150,000.00 | | 150,000.00 | |
| Galveston Jetty, Lighthouse Service | 6,500.00 | | 6,500.00 | |
| Fifth lighthouse district, additional buoys | 44,600.00 | | 44,600.00 | |
| Staten Island, N. Y., lighthouse depot | 65,000.00 | | 65,000.00 | |

### COMPARISON OF THE ITEMS OF ESTIMATES FOR THE DEPARTMENT OF COMMERCE SUBMITTED FOR THE FISCAL YEAR 1921 WITH THE APPROPRIATIONS ACTUALLY MADE BY THE CONGRESS FOR THE FISCAL YEAR 1920—Continued.

| | Estimates, 1921. | Appropriations, 1920. | Increase. | Decrease. |
|---|---|---|---|---|
| LIGHTHOUSE SERVICE—continued. | | | | |
| Public works—Continued. | | | | |
| Detroit lighthouse depot | $50,000.00 | | $50,000.00 | |
| Execution Rocks, Lighthouse Service | | $10,000.00 | | $10,000.00 |
| Point Jiquero, P. R., Lighthouse Service | | 24,000.00 | | 24,000.00 |
| Manitowoc Breakwater, Lighthouse Service | | 9,000.00 | | 9,000.00 |
| Chicago Harbor, Lighthouse Service | | 6,400.00 | | 6,400.00 |
| Lighthouse keepers' dwellings | | 50,000.00 | | 50,000.00 |
| Tompkinsville lighthouse depot | | 30,000.00 | | 30,000.00 |
| Third lighthouse district, riprap | | 150,000.00 | | 150,000.00 |
| Alaska, aids to navigation | | 75,000.00 | | 75,000.00 |
| Total | 16,374,168.40 | 7,044,830.00 | 9,683,738.40 | 354,400.00 |
| Decrease | | | 354,400.00 | |
| Net increase | | | 9,329,338.40 | |
| BUREAU OF THE CENSUS. | | | | |
| Expenses, Fourteenth Decennial Census | 6,215,000.00 | 15,000,000.00 | | 8,785,000.00 |
| BUREAU OF FOREIGN AND DOMESTIC COMMERCE. | | | | |
| Salaries | 337,920.00 | 220,510.00 | 117,410.00 | |
| Promoting commerce | 500,000.00 | 325,000.00 | 175,000.00 | |
| Promoting commerce, South and Central America | 150,000.00 | 100,000.00 | 50,000.00 | |
| Promoting commerce, Far East | 150,000.00 | 100,000.00 | 50,000.00 | |
| Commercial attachés | 300,000.00 | 165,000.00 | 135,000.00 | |
| Development of trade, motion pictures | 69,000.00 | | 69,000.00 | |
| Post allowances | 100,000.00 | | 100,000.00 | |
| Transporting remains | 1,500.00 | | 1,500.00 | |
| Transporting families | 50,000.00 | | 50,000.00 | |
| Total | 1,658,420.00 | 910,510.00 | 747,910.00 | |
| STEAMBOAT-INSPECTION SERVICE. | | | | |
| Salaries, Office of Supervising Inspector General | 24,140.00 | 22,940.00 | 1,200.00 | |
| Salaries, Steamboat-Inspection Service | 730,550.00 | 697,950.00 | 32,600.00 | |
| Clerk hire | 148,520.00 | 115,000.00 | 33,520.00 | |
| Contingent expenses | 190,000.00 | 160,000.00 | 30,000.00 | |
| Total | 1,093,210.00 | 995,890.00 | 97,320.00 | |
| BUREAU OF NAVIGATION. | | | | |
| Salaries, Bureau of Navigation | 45,130.00 | 39,730.00 | 5,400.00 | |
| Salaries, Shipping Service | 36,200.00 | 30,100.00 | 6,100.00 | |
| Clerk hire, Shipping Service | 85,800.00 | 50,000.00 | 35,800.00 | |
| Contingent expenses, Shipping Service | 12,365.00 | 8,365.00 | 4,000.00 | |
| Admeasurement of vessels | 5,000.00 | 3,500.00 | 1,500.00 | |
| Instruments for counting passengers | 250.00 | 250.00 | | |
| Enforcement of navigation laws | 80,142.00 | 43,000.00 | 37,142.00 | |
| Preventing overcrowding of passenger vessels | 18,000.00 | 18,000.00 | | |
| Enforcement of wireless-communication laws | 129,262.00 | 45,000.00 | 84,262.00 | |
| Total | 412,149.00 | 237,945.00 | 174,204.00 | |

COMPARISON OF THE ITEMS OF ESTIMATES FOR THE DEPARTMENT OF COMMERCE SUBMITTED FOR THE FISCAL YEAR 1921 WITH THE APPROPRIATIONS ACTUALLY MADE BY THE CONGRESS FOR THE FISCAL YEAR 1920—Continued.

| | Estimates, 1921. | Appropriations, 1920. | Increase. | Decrease. |
|---|---|---|---|---|
| BUREAU OF STANDARDS. | | | | |
| Salaries | $671,440.00 | $486,760.00 | $184,680.00 | |
| Equipment | 150,000.00 | 100,000.00 | 50,000.00 | |
| Repairs and alterations | 35,000.00 | 8,000.00 | 27,000.00 | |
| General expenses | 100,000.00 | 60,000.00 | 40,000.00 | |
| Improvement and care of grounds | 25,000.00 | 7,500.00 | 17,500.00 | |
| Testing structural materials | 250,000.00 | 125,000.00 | 125,000.00 | |
| Testing machines | 55,000.00 | 30,000.00 | 25,000.00 | |
| Investigation of fire-resisting properties | 65,000.00 | 25,000.00 | 40,000.00 | |
| Investigation of public utilities | 200,000.00 | 85,000.00 | 115,000.00 | |
| Investigation of railway materials | 25,000.00 | 15,000.00 | 10,000.00 | |
| Testing miscellaneous materials | 50,000.00 | 30,000.00 | 20,000.00 | |
| Radio-communication research | 75,000.00 | 30,000.00 | 45,000.00 | |
| Color standardization | 15,000.00 | 10,000.00 | 5,000.00 | |
| Investigation of clay products | 50,000.00 | 20,000.00 | 30,000.00 | |
| Physical constants | 25,000.00 | 5,000.00 | 20,000.00 | |
| Standardization and testing of mechanical appliances | 40,000.00 | 15,000.00 | 25,000.00 | |
| Investigation of optical glass | 75,000.00 | 20,000.00 | 55,000.00 | |
| Standard materials | 15,000.00 | 5,000.00 | 10,000.00 | |
| Investigation of textiles | 75,000.00 | 15,000.00 | 60,000.00 | |
| Sugar standardization | 30,000.00 | 20,000.00 | 10,000.00 | |
| Gauge standardization | 60,000.00 | 40,000.00 | 20,000.00 | |
| Mine scales investigation | 25,000.00 | 15,000.00 | 10,000.00 | |
| Metallurgical research | 75,000.00 | 25,000.00 | 50,000.00 | |
| Industrial pyrometry | 10,000.00 | 10,000.00 | | |
| Sound investigation | 20,000.00 | 5,000.00 | 15,000.00 | |
| Industrial research | 250,000.00 | 50,000.00 | 200,000.00 | |
| Industrial safety standards | 50,000.00 | | 50,000.00 | |
| Standardization of instruments, machinery, and equipment | 75,000.00 | | 75,000.00 | |
| Investigation of electrodeposition of metals | 20,000.00 | | 20,000.00 | |
| Investigation of chemical reagents | 15,000.00 | | 15,000.00 | |
| Weights and measures cooperation | 35,000.00 | | 35,000.00 | |
| Gas-measuring instruments investigation | 10,000.00 | | 10,000.00 | |
| Electrical investigations | 50,000.00 | | 50,000.00 | |
| Motor combustion and lubrication standards | 50,000.00 | | 50,000.00 | |
| Construction work | 10,000.00 | | 10,000.00 | |
| Standardization and investigation of internal-combustion engines | 150,000.00 | | 150,000.00 | |
| Low-temperature research and standardization | 20,000.00 | | 20,000.00 | |
| Aeronautic instrument investigation | 25,000.00 | | 25,000.00 | |
| Testing large scales | 60,000.00 | 40,000.00 | 20,000.00 | |
| Testing car depot | 50,000.00 | | 50,000.00 | |
| Building for power plant | 50,000.00 | | 50,000.00 | |
| Alteration of north laboratory | 60,000.00 | | 60,000.00 | |
| Moving and installation | | 100,000.00 | | $100,000.00 |
| Additional land | 50,000.00 | | 50,000.00 | |
| Total | 3,246,440.00 | 1,397,260.00 | 1,949,180.00 | 100,000.00 |
| Decrease | | | 100,000.00 | |
| Net increase | | | 1,849,180.00 | |

### COMPARISON OF THE ITEMS OF ESTIMATES FOR THE DEPARTMENT OF COMMERCE SUBMITTED FOR THE FISCAL YEAR 1921 WITH THE APPROPRIATIONS ACTUALLY MADE BY THE CONGRESS FOR THE FISCAL YEAR 1920—Continued.

| | Estimates, 1921. | Appropriations, 1920. | Increase. | Decrease. |
|---|---|---|---|---|
| BUREAU OF FISHERIES. | | | | |
| Salaries, Bureau of Fisheries | $146,460.00 | $112,940.00 | $33,520.00 | |
| Salaries, field service | 478,610.00 | 347,250.00 | 131,360.00 | |
| Miscellaneous expenses | 864,000.00 | 719,000.00 | 145,000.00 | |
| Auxiliary station, Mississippi River | 30,000.00 | | 30,000.00 | |
| Fish hatcheries: | | | | |
| Duluth | 15,000.00 | 4,000.00 | 11,000.00 | |
| New Hampshire | 20,000.00 | | 20,000.00 | |
| Northville, Mich | 50,000.00 | | 50,000.00 | |
| Rhode Island | 40,000.00 | | 40,000.00 | |
| St. Johnsbury, Vt | 10,000.00 | | 10,000.00 | |
| San Marcus, Tex | 7,500.00 | | 7,500.00 | |
| Saratoga, Wyo | 10,000.00 | | 10,000.00 | |
| Woods Hole, Mass | 15,000.00 | | 15,000.00 | |
| Wytheville, Va | 10,000.00 | 5,000.00 | 5,000.00 | |
| Cape Vincent, N. Y | | 8,000.00 | | $8,000.00 |
| Marine Biological Station, Key West, Fla | 110,000.00 | | 110,000.00 | |
| Fur-seal islands, Alaska | 20,000.00 | | 20,000.00 | |
| Development and improvement of herring fisheries, Alaska | 25,000.00 | | 25,000.00 | |
| Biological station, Fairport, Iowa | | 10,000.00 | | 10,000.00 |
| Power lighter for Pribilof Islands | | 7,500.00 | | 7,500.00 |
| Total | 1,851,570.00 | 1,213,690.00 | 663,380.00 | 25,500.00 |
| Decrease | | | 25,500.00 | |
| Net increase | | | 637,880.00 | |
| COAST AND GEODETIC SURVEY. | | | | |
| Party expenses | 777,221.00 | 494,600.00 | 282,621.00 | |
| Repairs of vessels | 82,500.00 | 56,000.00 | 26,500.00 | |
| Pay, etc., officers and men | 876,000.00 | 460,000.00 | 416,000.00 | |
| Salaries | 747,010.00 | 523,680.00 | 223,330.00 | |
| General expenses | 95,000.00 | 104,000.00 | | 9,000.00 |
| Filing cases | 10,000.00 | | 10,000.00 | |
| Skylight | 1,500.00 | | 1,500.00 | |
| New vessels | 1,080,000.00 | | 1,080,000.00 | |
| Four or more launches | 68,000.00 | | 68,000.00 | |
| Total | 3,737,231.00 | 1,638,280.00 | 2,107,951.00 | 9,000.00 |
| Decrease | | | 9,000.00 | |
| Net increase | | | 2,098,951.00 | |
| Printing and binding | 386,430.00 | 300,000.00 | 86,430.00 | |
| RECAPITULATION. | | | | |
| Office of the Secretary | 343,450.00 | 314,550.00 | 28,900.00 | |
| Lighthouse Service | 16,374,168.40 | 7,044,830.00 | 9,683,738.40 | 354,400.00 |
| Bureau of the Census | 6,215,000.00 | 15,000,000.00 | | 8,785,000.00 |
| Bureau of Foreign and Domestic Commerce | 1,658,420.00 | 910,510.00 | 747,910.00 | |
| Steamboat-Inspection Service | 1,093,210.00 | 995,890.00 | 97,320.00 | |
| Bureau of Navigation | 412,149.00 | 237,945.00 | 174,204.00 | |

COMPARISON OF THE ITEMS OF ESTIMATES FOR THE DEPARTMENT OF COMMERCE SUBMITTED FOR THE FISCAL YEAR 1921 WITH THE APPROPRIATIONS ACTUALLY MADE BY THE CONGRESS FOR THE FISCAL YEAR 1920—Continued.

| | Estimates, 1921. | Appropriations, 1920. | Increase. | Decrease. |
|---|---|---|---|---|
| RECAPITULATION—continued. | | | | |
| Bureau of Standards | $3,246,440.00 | $1,397,260.00 | $1,949,180.00 | $100,000.00 |
| Bureau of Fisheries | 1,851,570.00 | 1,213,690.00 | 663,380.00 | 25,500.00 |
| Coast and Geodetic Survey | 3,737,231.00 | 1,638,280.00 | 2,107,951.00 | 9,000.00 |
| Printing and binding | 386,430.00 | 300,000.00 | 86,430.00 | ........... |
| Grand total | 35,318,068.40 | 29,052,955.00 | 15,539,013.40 | 9,273,900.00 |
| Decrease | ........... | ........... | 9,273,900.00 | ........... |
| Net increase | ........... | ........... | 6,265,113.40 | ........... |

## Personnel.

The accompanying table shows, by bureaus, the number of permanent positions in the Department on July 1, 1919, and the increase or decrease in each bureau as compared with July 1, 1918. The figures do not include temporary appointments, nor do they include the following appointments or employments not made by the head of the Department: Persons engaged in rodding, chaining, recording, heliotroping, etc., in field parties of the Coast and Geodetic Survey; temporary employments in field operations of the Bureau of Fisheries; mechanics, skilled tradesmen, and laborers employed in field construction work in the Lighthouse Service. Enlisted men on vessels of the Coast Survey in the Philippine Islands and officers and men of the Navy Department employed on vessels of the Bureau of Fisheries are also excluded. The total of these excluded miscellaneous employments and enlistments is approximately 5,000, as compared with 4,444 for the fiscal year 1918. At the close of the fiscal year 1919 there were 1,262 employees in the service of the Department serving under temporary appointment or employment.

The total number of permanent positions referred to in the accompanying table, together with the employments and enlistments just mentioned, on July 1, 1919, was approximately 12,340, as compared with 11,051 on July 1, 1918.

| Bureau. | Statutory. | Nonstatutory. | Total. | In District of Columbia. | Outside District of Columbia. | Increase (+) or decrease (−). |
|---|---|---|---|---|---|---|
| Office of the Secretary | 183 | .......... | 183 | 183 | .......... | 5 |
| Bureau of the Census | 636 | 712 | 1,348 | [a] 695 | 653 | − 49 |
| Bureau of Foreign and Domestic Commerce | 152 | 153 | 305 | [a] 174 | 131 | 85 |
| Bureau of Standards | 381 | 615 | 996 | 902 | 94 | − 65 |
| Bureau of Fisheries | 424 | 4 | 428 | 82 | 346 | 8 |
| Bureau of Lighthouses | 56 | 5,762 | [b] 5,818 | 43 | 5,775 | − 5 |
| Coast and Geodetic Survey | 336 | 606 | 942 | [a] 369 | 573 | [c] 402 |
| Bureau of Navigation | [d] 45 | 159 | 204 | 45 | 159 | − 29 |
| Steamboat-Inspection Service | 311 | 97 | 408 | 14 | 394 | 61 |
| Total | 2,524 | 8,108 | 10,632 | 2,507 | 8,125 | 413 |

[a] Employees engaged in work in the field for a part of each year, with headquarters in Washington, are treated as within the District of Columbia.

[b] Includes the following positions, appointment to which is not made by the head of the Department: 415 mechanics, skilled tradesmen, and laborers employed in field construction work in the Lighthouse Service and work of a similar character at the general lighthouse depot at Tompkinsville, N. Y.; 1,513 laborers in charge of post lights; and 1,343 members of crews of vessels.

[c] Includes employees on vessels retransferred from the jurisdiction of the Navy Department. Comparable statistics in last year's report showed a loss of 250 for this Bureau.

[d] Includes 2 stenographers and typewriters authorized by law, for not exceeding 6 months during the year

The following table gives a summary of changes in the personnel of the Department for the fiscal year ended June 30, 1919:

| Bureau. | Appointments.[a] | | | | | | Promotions. | Reductions. |
|---|---|---|---|---|---|---|---|---|
| | Permanent. | | | | Temporary. | Grand total. | | |
| | Competitive. | Excepted. | Unclassified. | Total. | | | | |
| Office of the Secretary | 90 | 2 | 12 | 104 | 186 | 290 | 76 | ........ |
| Bureau of the Census | 178 | ........ | 488 | 666 | 473 | 1,139 | 410 | 1 |
| Bureau of Foreign and Domestic Commerce | 88 | 79 | ........ | 167 | 148 | 315 | 159 | 1 |
| Bureau of Standards | 554 | 14 | 27 | 595 | 1,314 | 1,909 | 774 | 23 |
| Bureau of Fisheries | 94 | 6 | 14 | 114 | 118 | 232 | 46 | 3 |
| Bureau of Lighthouses | 441 | 15 | ........ | 456 | 482 | 938 | 2,239 | [b] 79 |
| Coast and Geodetic Survey | 60 | 10 | 6 | 76 | 227 | 303 | 98 | 14 |
| Bureau of Navigation | 44 | 19 | 7 | 70 | 67 | 137 | 45 | ........ |
| Steamboat-Inspection Service | 159 | ........ | ........ | 159 | 80 | 239 | 300 | 1 |
| Total | 1,708 | 145 | 554 | 2,407 | 3,095 | [c] 5,502 | 4,147 | 122 |

[a] Includes appointments of the following characters: Presidential, by selection from civil-service certificates, under Executive order, to excepted positions, by reinstatement and by reason of transfer within the Department or from other departments or independent establishments.

[b] Mainly voluntary reductions accepted by employees to secure more desirable conditions of living.

[c] Includes a large number of appointments by reason of increase of compensation.

| Bureau. | Separations.[a] | | | | | | Miscellaneous changes.[b] |
|---|---|---|---|---|---|---|---|
| | From permanent positions. | | | | From temporary positions. | Grand total. | |
| | Competitive. | Excepted. | Unclassified. | Total. | | | |
| Office of the Secretary | 82 | 3 | 2 | 87 | 112 | 199 | 51 |
| Bureau of the Census | 125 | ........ | 870 | 995 | 34 | 1,029 | 45 |
| Bureau of Foreign and Domestic Commerce | 70 | 19 | ........ | 89 | 58 | 147 | 30 |
| Bureau of Standards | 372 | 1 | 5 | 378 | 1,127 | 1,505 | 89 |
| Bureau of Fisheries | 59 | ........ | 2 | 61 | 57 | 118 | 5 |
| Bureau of Lighthouses | 413 | 4 | ........ | 417 | 238 | 655 | 78 |
| Coast and Geodetic Survey | 55 | 3 | ........ | 58 | 89 | 147 | 58 |
| Bureau of Navigation | 41 | 2 | 2 | 45 | 36 | 81 | 23 |
| Steamboat-Inspection Service | 41 | ........ | ........ | 41 | 13 | 54 | 17 |
| Total | 1,258 | 32 | 881 | 2,171 | 1,764 | 3,935 | 396 |

[a] Includes separations by reason of resignations, discontinuances, removals, deaths, transfers within the Department, and transfers from the Department to other departments or independent establishments.

[b] Includes reappointments by reason of change of station, name, designation, extensions of temporary appointments, changes from temporary to permanent status, etc.

In spite of the unusual number of losses of employees during the last fiscal year and the difficulty of securing qualified appointees, the Department has maintained its policy of filling upper-grade vacancies by promoting employees whenever possible and discouraging the filling of such vacancies by making appointments from outside its service. This policy is well established and is appreciated by the employees, who thereby have an incentive to prepare themselves for more responsible duties, thus acquiring a more general knowledge of the Department's activities and increasing their value to it. It also has a tendency to minimize the desire to seek better-paid opportunities elsewhere, which has become abnormally evident and causes much derangement of governmental work.

Among certain classes of the Department's employees where outside competition was keen, the Department, in order to maintain efficient service, has been compelled from time to time to increase the salaries paid. In no other manner was it possible to retain a sufficient force among such classes as mechanics, crews, and officers of vessels, etc.

The following table shows a net decrease in the average amount of leave utilized by employees during the last year, in spite of a considerable increase in the amount of sick leave used, resulting from the epidemic of Spanish influenza prevalent in the latter part of 1918:

### Total and Average Amount of Annual and Sick Leave, by Bureaus, Stated Separately and Together, Taken by Employees of the Department in the District of Columbia, Arranged According to Sex, During the Calendar Year 1918, and Average Leave for 1917.

| Bureau. | Number.[b] | Annual leave.[a] |  | Sick leave. |  | Total. |  | Average, 1917. |
|---|---|---|---|---|---|---|---|---|
|  |  | Days. | Average. | Days. | Average. | Days. | Average. |  |
| **MALE.** |  |  |  |  |  |  |  |  |
| Office of the Secretary | 67 | 1,711 | 25.54 | 514 | 7.67 | 2,225 | 33.21 | 28.55 |
| Bureau of the Census | 283 | 8,030 | 28.37 | 2,284 | 8.07 | 10,314 | 36.45 | 34.83 |
| Bureau of Foreign and Domestic Commerce | 74 | 1,979 | 26.74 | 785 | 10.61 | 2,764 | 37.35 | 35.17 |
| Bureau of Standards | 398 | 5,880 | 14.77 | 2,096 | 5.27 | 7,976 | 20.04 | 24.59 |
| Bureau of Fisheries | 41 | 1,047 | 25.54 | 247 | 6.02 | 1,294 | 31.56 | 30.72 |
| Bureau of Lighthouses | 21 | 597 | 28.43 | 221 | 10.52 | 818 | 38.95 | 33.78 |
| Coast and Geodetic Survey | 128 | 3,578 | 27.95 | 1,230 | 9.61 | 4,808 | 37.56 | 32.24 |
| Bureau of Navigation | 16 | 386 | 24.13 | 64 | 4.00 | 450 | 28.13 | 32.17 |
| Steamboat-Inspection Service | 5 | 132 | 26.40 | 50 | 10.00 | 182 | 36.40 | 29.00 |
| Total and average | 1,033 | 23,340 | 22.59 | 7,491 | 7.25 | 30,831 | 29.85 | 30.70 |
| **FEMALE.** |  |  |  |  |  |  |  |  |
| Office of the Secretary | 43 | 1,186 | 27.58 | 472 | 10.98 | 1,658 | 38.56 | 35.29 |
| Bureau of the Census | 245 | 7,345 | 29.98 | 3,217 | 13.13 | 10,562 | 43.11 | 41.85 |
| Bureau of Foreign and Domestic Commerce | 26 | 744 | 28.62 | 429 | 16.50 | 1,173 | 45.12 | 37.62 |
| Bureau of Standards | 26 | 482 | 18.54 | 200 | 7.69 | 682 | 26.23 | 59.00 |
| Bureau of Fisheries | 22 | 640 | 20.09 | 253 | 11.50 | 893 | 40.59 | 41.57 |
| Bureau of Lighthouses | 4 | 118 | 29.50 | 68 | 17.00 | 186 | 46.50 | 53.50 |
| Coast and Geodetic Survey | 20 | 573 | 28.65 | 256 | 12.80 | 829 | 41.45 | 42.29 |
| Bureau of Navigation | 7 | 210 | 30.00 | 82 | 11.71 | 292 | 41.71 | 42.83 |
| Steamboat-Inspection Service | 4 | 120 | 30.00 | 36 | 9.00 | 156 | 39.00 | ........ |
| Total and average | 397 | 11,418 | 28.76 | 5,013 | 12.63 | 16,431 | 41.39 | 41.08 |
| **TOTAL.** |  |  |  |  |  |  |  |  |
| Office of the Secretary | 110 | 2,897 | 26.34 | 986 | 8.96 | 3,883 | 35.30 | 30.81 |
| Bureau of the Census | 528 | 15,375 | 29.12 | 5,501 | 10.42 | 20,876 | 39.54 | 37.97 |
| Bureau of Foreign and Domestic Commerce | 100 | 2,723 | 27.23 | 1,214 | 12.14 | 3,937 | 39.37 | 35.50 |
| Bureau of Standards | 424 | 6,362 | 15.00 | 2,296 | 5.41 | 8,658 | 20.42 | 24.85 |
| Bureau of Fisheries | 63 | 1,677 | 26.77 | 500 | 7.94 | 2,187 | 34.71 | 33.67 |
| Bureau of Lighthouses | 25 | 715 | 28.60 | 289 | 11.56 | 1,004 | 40.16 | 35.30 |
| Coast and Geodetic Survey | 148 | 4,151 | 28.05 | 1,486 | 10.04 | 5,637 | 38.09 | 33.17 |
| Bureau of Navigation | 23 | 596 | 25.91 | 146 | 6.35 | 742 | 32.26 | 33.56 |
| Steamboat-Inspection Service | 9 | 252 | 28.00 | 86 | 9.56 | 338 | 37.56 | 29.00 |
| Total and average | 1,430 | 34,758 | 24.30 | 12,504 | 8.74 | 47.262 | 33.05 | 33.30 |

[a] In the count of the annual leave, all periods of one-half day and over were counted as full days; periods of less than one-half day were omitted.

[b] Only those employees were included who are considered as being entitled to the full yearly allowance of both annual and sick leave.

**Superannuation and Retirement.**

The annual reports of this Department during the past six years have presented the subject of retirement of superannuated and disabled Government employees. Hence it may hardly be necessary to add further expression of my views; yet I regard the subject as of such importance that I must not leave undone anything within my power to advance it. I look at it from the standpoint of common justice, on the one hand, and from that of efficient service, on the other hand. Large private concerns recognize that a lifetime spent in their service carries with it an obligation of honor toward the employee who has thus served faithfully when years make him incapable of further effective work. The business house that would turn out an aged employee, saying to him in substance "Now look out for yourself" after a long and good record would be damned by the common opinion of the business world, and deservedly so. The only conceivable excuse that could be made would be that the employer had paid during the long service a sufficient salary over and above all the exigencies of life to have enabled the employee to provide himself for his own old age. No one will charge the Government with doing that. Failure to be as just in these matters as private concerns are, injures the Government either by causing the ambitious to seek better opportunities elsewhere or by relaxing the efforts of its employees generally through the unconscious drag that comes from hopeless service. The result of the present condition is seen in the survival of many old people in the Government work who struggle on because they needs must, when they should have ceased from their labors. Enactments requiring these aged workers to be discharged are substantially repealed by the higher law of humanity. They are demoted and maintained at reduced pay, thus creating what is in substance a pension without retirement, without the dignity of a recognition by the Government of their worth, and maintaining the inefficiency which everyone seeks to remove.

I am not especially concerned as to the details of any measure that may ameliorate this evil. During the present Congress many bills have been introduced for this purpose, one, the Lehlbach-Sterling bill, has passed the House of Representatives and has been introduced into the Senate. It may, perhaps, be susceptible of improvement, but it is a recognition of a claim and an attempt to remove an incubus on the wheels of governmental business.

It is to be hoped that the bill may shortly become law, and thus at once justly provide for those who have served many years, open the door to more rapid promotion and to larger opportunities for younger and more active employees, and make the Government work more efficient not only through the removal of ineffectives, but by the unconscious but very real self-discipline that comes in response to wise and far-seeing treatment of the employee. I firmly believe that after a year of experience with any sound retirement system no voices will be lifted against it.

**Salaries.**

The Department has followed its usual practice of filling vacancies by promoting the clerks in the service instead of filling the higher-salaried positions with appointees from the civil-service registers without experience in Government work. It has been shown by experience to be a wise course, for it gives to every clerical employee assurance that faithful attendance to duty will bring about promotion in due time. It has developed, however, that many of the $900 positions can not be filled permanently, as that entrance salary, even including the bonus of $240 allowed during the present year, possesses no attraction as compared with the compensation offered by private employers. Competent clerks could be secured before the war at an entrance salary of $900. They can not be had now. The positions that are thus vacant are needed for the work of the Government. The inability to fill them reduces the force, already insufficient, and imposes an undue strain upon employees in the higher grades whose duties are already heavy.

The present $900 entrance salary for clerks should be abolished. Even with the bonus it is not sufficient to secure experienced clerks, notably stenographers and typewriters, who can readily obtain from $1,200 to $1,500 per annum elsewhere. There is a chronic dearth of this class of eligibles on the registers of the Civil Service Commission. The entrance compensation for clerks should be at least $1,200 per annum, which is not more than is paid in many places for common labor.

The Nolan minimum compensation bill now before Congress is an attempt to minimize the hardship involved in the combination of low salary and high cost of living in cases where it bears most heavily. It is, however, but a partial solution of the problem. It is hoped that systematic and adequate relief in this respect will be accomplished through the work of the congressional Joint

Commission on Reclassification of Salaries established under the act of March 1, 1919.

The Department has cooperated actively with the Joint Commission on Reclassification of Salaries and hopes that the studies of that commission will result in an improvement of existing conditions. The plain fact is that many of the Government workers are to-day unable to live, even with the severest economy, upon the pay which they receive. They are forced to run into debt, are obliged to seek separate means of adding to their income, or are forced to withdraw from the service because other employers are more appreciative than the Government of existing conditions.

The legislative, executive, and judicial appropriation act approved March 1, 1919, provides $240 per annum increase of compensation for the fiscal year 1920, in lieu of the $120 bonus allowed during the past fiscal year, in recognition of the necessity under present living conditions for upward revision of salaries. This but partially meets current necessities. The temporary increase is not comparable with the increase in the cost of living.

If, to the high prices of all necessary articles required for living, there be added the demands for subscriptions to Government loans, to the Red Cross, calls for the purchase of War Savings Stamps, and other outlays which, however fine, useful, or even thrifty, still call for payment from a fixed sum of amounts which are large in proportion thereto—if, let it be repeated, these demands are aggregated and against them is weighed the fact that during one fiscal year a bonus of but $120 was added and in a second year a bonus of $240, it must be evident not only that these bonuses are hopelessly inadequate to meet the situation, but that the net result of the pressure upon many faithful and hard-working people has been really tragic. It is astonishing how generous the working force of this Department has been in matters of public helpfulness (see detailed description on p. 68) when the conditions of life have been so hard.

There have, furthermore, been cases where real injustice has been done. In the Lighthouse Service the salaries of keepers have been raised by the act of Congress approved June 20, 1918. In the same Service the wages of seamen and officers on board vessels have also been raised, following the official action of the Navy Department and the Shipping Board. This, however, has left the field supervising and clerical force where they were before the war, save for the bonus. The result has been an actual discrimination against a portion of a service quite as worthy as those who have been more favored. Yet the requests made of Congress for funds sufficient to remove this act of real injustice have been refused. Under date of August 14, 1919, the superintendent of the eighteenth lighthouse district (San Francisco, Calif.) wrote the Commissioner of Lighthouses as follows:

> The base pay of $960 per annum with a bonus of $240 per annum is practically the lowest paid by any Government service in this city, and only the poorer class of eligibles will accept an appointment in this district. It is feared that with this low base pay a class of clerks far below the average in efficiency will enter the Lighthouse Service and in the course of time prove a very serious handicap to the handling of the district work.

Indeed the funds allotted for the Lighthouse Service in all respects, whether as to keepers' salaries, the wages of seamen and officers on vessels, or the wages of its field supervising and clerical force, are far from sufficient to carry that Service through the fiscal year, and a very considerable sum will be necessary unless the work of that Service is to be actually shut off in large part before the year closes.

During the last two years the Bureau of Standards has lost nearly or quite 50 per cent of its technical staff. This applies to all grades of trained scientific and technical men, but is especially true of the leaders in specific lines. The salaries of these men in the laboratories of the industries or in consultation work are usually double those which the Bureau of Standards is permitted to pay. To make this entirely clear a table is given below in which the names are represented by letters, stating actual cases of experts who have left the service for other salaries and giving the salaries paid elsewhere:

| Name. | Title at Bureau. | Bureau salary. | Salary outside. | Title outside. |
|---|---|---|---|---|
| A | Chief of paper section | $2,700 | $7,200 | Director of department of technical control of the largest paper concern in the country. |
| B | Senior associate physicist in metallurgical division. | 3,300 | 5,000 | Research metallurgist in large metal corporation. |
| C | Electrical engineer | 3,300 | 4,500 and promise. | Electrical engineer. |
| D | Chief of textile section | 2,500 | About double. | Consulting textile expert. |
| E | Associate physicist, in charge paper laboratory. | 2,500 | Nearly double. | Head of research utilization and new developments in a large paper concern operating 12 mills. |
| F | Chief, magnetic laboratory | 2,500 | Two or three times more.[a] | Consulting expert. |
| G | Gas engineer | 2,520 | 3,300 | Gas engineer in large gas corporation. |

[a] Refused outside offer of $7,500.

The following table gives cases in which private firms have offered the technical experts of the Bureau of Standards higher salaries than those they are receiving. In some of these cases the experts were asked by outside employers to name their own price, yet they have remained at the Bureau of Standards at a personal sacrifice, which it is wholly unfair as well as unwise to ask them longer to continue.

| Name. | Title at Bureau. | Bureau salary. | Salary outside. | Title outside. |
|---|---|---|---|---|
| H...... | Chief, division of ceramics and optical glass. | $4,800 | $10,000 | Ceramics chief. |
| I....... | Physicist and chief of the metallurgical division. | 4,000 | 7,500 | Scientific metallurgist in charge of American end of large metal corporation. |
| J....... | Optical-glass expert........... | 2,500 | 5,000 | Technical expert in optical-glass factory. |
| K...... | Associate physicist and metallographist. | 2,700 | 4,000 | Metallographist in aluminum corporation. |
| L...... | Chief, gage section............. | 3,000 | [a] 5,000 | Chief of gage manufacture in large industrial concern. |

[a] Contract arranges for increase; base salary is guaranteed.

The above examples are chosen from the higher grades, but facts in the same proportion exist in all grades of the scientific and technical staff. If this process is to continue, many lines of the bureau's investigational work will have to be abandoned. The best we can hope to do at the low salaries now provided is to maintain a few untrained men for routine and testing work, and even this will suffer for lack of proper supervision.

The Bureau of Standards has more than 100 specialized lines of scientific and technical work. Each demands an expert of experience and ability, able to plan and supervise research and testing of a superior grade. The bureau can not pay the salaries demanded by men who are already trained and have the requisite administrative experience, since there are but 30 positions in the grades from $3,000 to $3,500 per annum, inclusive.

A critical situation, therefore, arises, since, even when the bureau trains competent men and fits them to become chiefs of sections, the industries pick them off as fast as they become thoroughly competent. The reason is solely the low salaries the bureau is able to pay and (even at such salaries) the relatively small number of good positions compared with the number of specialized fields in the bureau. The case becomes even more serious when it is remembered that the Bureau of Standards is expected to be the leader in each of these specialized fields of scientific and technical work.

At least 10 Government boards and commissions have chiefs who receive in excess of that paid at the Bureau of Standards. The salaries of such chiefs range from $7,500 to $12,000 for training and experience not more highly technical or exacting than that required for the Bureau of Standards. The highest technical salary (apart from Director) at the Bureau of Standards is $4,800. The following partial list shows Government positions paying in excess of the bureau's maximum:

| | |
|---|---|
| Federal Trade Commission: | |
| 5 commissioners | $10,000 |
| 1 secretary | 5,000 |
| U. S. Tariff Commission: | |
| Chairman | 7,500 |
| 5 commissioners | 7,500 |
| Secretary | 5,000 |
| U. S. Shipping Board: | |
| 5 commissioners | 7,500 |
| Secretary | 5,000 |
| 2 special experts | 5,000 |
| Chief counsel | 10,000 |
| Board of Mediation, etc.: | |
| Commissioner | 7,500 |
| Assistant commissioner | 5,000 |
| Interstate Commerce Commission: | |
| 9 commissioners | 10,000 |
| Secretary | 5,000 |
| Federal Board for Vocational Education: | |
| 3 members | 5,000 |
| Chief of division | 6,000 |
| 2 chiefs of divisions | 5,000 |
| 2 assistant directors | 4,500 |
| 1 assistant director | 4,250 |
| Pan American Union: | |
| Director general | $7,500 |
| Assistant director | 4,700 |
| Federal Reserve Board: | |
| Chairman, Secretary of Treasury (ex officio). | |
| Governor | 12,000 |
| Vice governor | 12,000 |
| 3 members | 12,000 |
| Comptroller of Currency (ex officio) (plus $5,000, Comptroller's salary) | 7,000 |
| Secretary | 9,000 |
| 1 chief of division | 6,000 |
| 1 chief of division | 5,500 |
| International Joint Commission: | |
| Chairman | 7,500 |
| 2 commissioners | 7,500 |
| Secretary | 4,000 |
| Panama Canal: | |
| General purchasing officer | 4,620 |
| Inspecting engineer | 4,400 |
| Chief clerk purchasing department | 4,000 |
| Assistant auditor | 4,000 |
| Assistant engineer | 3,720 |

The above table shows that 19 positions outside of the Bureau of Standards pay double the maximum expert salary. Salaries of $10,000 and over per annum are not at all unusual with large industrial corporations for experts carrying on scientific and technical work; yet these men thus paid are those who consult the experts of the Bureau of Standards and are assisted by them.

It would be interesting to compare the salaries paid in the Railroad Administration not only with those given members of the Cabinet, but those paid the heads of country-wide services employing thousands of men and large equipment. It is a plain truth that on the whole the insufficiency of Government salaries in the higher, responsible positions approaches the scandalous.

By the act of Congress approved July 2, 1918, the pay of the inspectors of the Steamboat-Inspection Service was materially increased. The increase was, however, not as great as it should have been, nor proportionate with the increase received by men in outside employment doing the same kind of work.

The clerks in the Steamboat-Inspection Service should also receive an increase in pay. The work of the field clerks of the Steamboat-Inspection Service is of a peculiar nature. It is well known that the maritime law is entirely different from the common law, and that the rules and procedure in admiralty are entirely different from the other procedure, and in the same way the organization of the Steamboat-Inspection Service is peculiar to itself. No other bureau in the Government has as many unusual and peculiar conditions to meet as the Steamboat-Inspection Service. The clerks must, therefore, be especially trained for the work they have to do before they are in any way efficient. The expansion in shipping has been tremendous, and incident thereto an enormous increase in the amount of work of that service. This work has been done without a murmur, and, as the inspectors have been rewarded, so should the clerks be.

The salaries for the vast majority of the classified positions in the Bureau of Fisheries have remained virtually stationary for about 30 years.

There is a large loss of effectiveness because of the grossly inadequate salaries paid throughout the service, but especially in the technical grades. It is unfair and demoralizing to employees qualified in fish culture, biology, and fishery technique to receive on the average much lower compensation than is given to unskilled laborers in private business.

The bureau has 13 clerical positions at $900 each, and only 22 of higher grades, with salaries ranging from $1,000 to $1,800. The service is overcrowded at the bottom, and there is little opportunity for advancing capable and deserving employees. From July 1, 1917, to July 1, 1919, there have been 16 resignations in the $900 grade because better pay could be obtained elsewhere. The present condition is very serious, due to the difficulty of obtaining and retaining intelligent employees with ability and initiative. The time of chiefs of division is occupied to such an extent by routine work that should be handled by subordinates that they have altogether too little opportunity for the important administrative matters of their divisions.

A readjustment of salaries in the field force attached to hat eries is imperative. The present rate of pay was establish more than a quarter of a century ago. The bureau for several years has been unable to induce desirable and qualified persons to enter this service at the meager compensation offered. The statutory base pay for apprentice fish-culturists is from $600 in the United States proper to $900 in Alaska; $900 to $1,200 for fish-culturists and foremen; and $1,500 for station superintendents. The latter officials are responsible for Government property valued at thousands of dollars and for the efficient operations of their respective hatcheries where important fish-cultural operations are carried on. The lowest base compensation for the grades mentioned should be $900, $1,200, and $2,000, respectively.

It must be remembered that the Bureau of Fisheries requires a force especially equipped for its work. All of its employees must be trained for the business, and before receiving permanent appointments must pass a suitable civil-service examination.

The wage problem in the vessel service is a similar one. The positions of assistants in charge of divisions require men with long, technical training and experience and are now filled by highly qualified persons whose work is most effective and meets with the hearty support of the fishery interests and the general public. The present salaries attached to these positions are materially under those for corresponding positions or similar service in other bureaus of the Government. In 12 bureaus of 3 departments, excluding the Bureau of Fisheries, the average salary paid to a division chief or for similar positions is $3,473, while in the latter Bureau it is $2,600.

The bureau is now faced with the serious problem of preventing the inevitable deterioration of the service if it is to be composed of only those who can find no other employment, those who have independent means, or of those who will voluntarily forego the privileges and responsibilities of family life or condemn their children to the deprivation of many ordinary comforts and the opportunities for special education.

I invite attention to the nature, extent, diversity, and amount of the work performed by the Commissioner, Deputy Commissioner, chief clerk, and chief of tonnage division of the Bureau of Navigation in the hope that these officers may be paid properly. All these officers are men who by long training and experience are especially qualified for the work. The increase recommended is not based entirely on the work of this bureau during the past four years, which was increased rather than diminished by the multiplication of marine agencies and the scattering of marine work among them during the war. Although most of the statutory work of the Bureau of Navigation continued to be performed during this period, much of its time and efforts were required to assist other branches of the Government, hurriedly organized, and in consequence not conversant with all the subjects with which they had to deal or with the acts of Congress governing those subjects and not to be ignored.

My recommendation is based on the elementary principle that the laborer is worthy of his hire. The Bureau of Navigation since 1884 by statute has general superintendence of the commercial marine and merchant seamen. This general jurisdiction of late years has been extended by the addition of new specific duties developed by inventions and progress such as the administration of laws relating to wireless apparatus and operators, motor-boat legislation, and other services specially provided for. The essential fact, however, is that we now have a merchant fleet in tonnage alone almost double the commercial fleet of 1914. Of more consequence, however, than the amount of tonnage is the fact that we now have in foreign trade alone a tonnage equal to that of our entire merchant fleet in 1914. During the current year this fleet will probably be increased by nearly 4,000,000 gross tons. In the foreign trade our ships must conform in many respects to the laws of the countries they visit, and the whole range of duties involved in Government supervision over and cooperation with merchant shipping is thus extended and made difficult by comparison with the simpler duties the Government assumes in the regulation of the domestic or coasting trade. My own observation accords with the views of practical shipping men and shipbuilders that the great increase in our fleets and their radius of commercial activity, due partly to the stimulation of the early years of the war, partly to the great appropriations by Congress after we entered the war, call for a better-paid and increased force to deal with shipping matters. With the concurrence of the Bureau of Navigation the necessary steps to remedy this condition were held in abeyance during the war, and since the end of the war nothing has been done in this connection.

The Commissioner of Navigation is probably the country's leading expert in the law, customs, and practice of the maritime profession. His long service of over a quarter of a century has given him peculiar familiarity with our national maritime laws. He is personally acquainted with the leading maritime officers, private and public, of other nations, and his counsel is by them sought and respected. It is a pitiful thing that such an officer should have to serve for a salary as small as $4,000 per annum. This is the smallest salary paid any bureau chief in the Department of Commerce and less than is paid in other positions of inferior authority.

The work of the Deputy Commissioner requires not only a knowledge of the application of the many laws administered by the bureau, but also judicial sense in the consideration annually of about 7,000 applications for the mitigation or remission of penalties in which he takes the preliminary action and makes recommendations. Direct administrative supervision of the various services of the bureau in the field requires also good business sense and promptitude. The Deputy Commissioner has amply demonstrated to my own satisfaction, and, I am confident, to the satisfaction of those who have dealings with this office, the possession of those qualities.

Through long experience the chief clerk has an intimate acquaintance with all phases of the bureau's work and with its relations to other branches of the service both here and in the field which it is hard to assess in money terms. I know of very few others who do so much work on which general reliance for accuracy must be placed who receive pay so incommensurate with the work.

The record and statistical work of this bureau in charge of the head of the tonnage division of only eight clerks is accepted as authority both here and abroad, and during the past four years, when attention has been focused on shipping, the work and forecasts of the chief of this division has stood all tests of criticism.

The salaries provided for the executive officers of the Bureau of Foreign and Domestic Commerce are entirely inadequate for the class of men demanded and the services performed. Increases should be provided, at least, for the Director, the two Assistant Directors, and the chief clerk. It is recommended that the salary of the Director be raised to $8,000, of the First Assistant Director to $4,500, and of the Second Assistant Director to $4,000, and that the chief clerk be made an administrative assistant at $3,500.

A number of new positions should be provided in order to carry on the more important work of the bureau, as well as in the clerical grades. Requests have, therefore, been made for one additional chief of section at $2,500, one at $2,250, and four at $2,000 each, and an increase of six assistant chiefs of divisions at $2,250. Recommendations for 1 additional clerk at $1,800, 14 at $1,600 2 at $1,400, and 56 at $1,200 are also submitted.

In arriving at the estimate for increases in the statutory force, the Bureau of Foreign and Domestic Commerce believes that the force recommended is the absolute minimum if it is to distribute to the public properly and promptly the mass of material furnished by its field employees, as well as by the consular officers throughout the world.

As a result of the funds appropriated by Congress to meet the increased cost of living abroad, the Bureau of Foreign and Domestic Commerce was able to grant post allowances (which were urgently needed) to the commercial attachés and their secretaries. Even with these increases in income, three of the attachés resigned during the year to accept more remunerative positions in private employ. It has been impossible at many posts to obtain or retain capable secretaries because of the low salary limit imposed by law and the exceptionally high cost of living abroad.

The question of obtaining living salaries for the employees of the Coast and Geodetic Survey is a vital one. This bureau was organized in 1816; and is the oldest scientific arm of the Federal Government. At its beginning the entire field force consisted of the Superintendent at a salary of $6,000 per annum and the two or three engineers under him, and necessarily the work, though most important, was comparatively limited in extent. To-day the field extends over and around the entire United States possessions, and the field and office force are commensurately greater and the labor far more arduous. The only element that has not largely increased is the recompense of the officers and men. Beginning with the Superintendent, his salary 103 years ago was $6,000 and still remains the same. The hydrographic and geodetic engineers, while receiving slight increases during the past five years, should have years ago been paid salaries as large as those paid officers in the Army and Navy performing similar services.

Nearly 20 per cent of the commissioned officers of this service have resigned during the period January 1 to October 1, 1919. These officers give in every case as a reason the fact that they can not live on the wages which the Government pays. As this is written, there is published a statement respecting the officers and men of the Navy to the effect that hundreds of naval officers are resigning because of insufficient pay, and an increase is said to be sought in the officers' pay of 30 per cent and in the pay of seamen of 50 per cent over the present rate. It is earnestly hoped these increased recompenses may be permitted, and that the bill providing for this increase may be amended to include the commissioned personnel of the Coast and Geodetic Survey, as requested by me in a letter dated October 1, 1919, to the Speaker of the House of Representatives.

Further, the bureau has need for many more computers than are now authorized, and the entrance and lower-grade salaries should be made higher. There are portfolios of field observations containing thousands of triangulation and precise leveling observations in the archives of the bureau that have never been computed. Indeed, so inadequate is the computing force of the bureau to meet the present needs, that the expedient has been adopted of putting into print the results from the latest field work and gradually working backward into the old material. If this were not done, the work would be very many years old before it would be put into print. As it is, the public is deprived of the benefits of this information that has cost many years of labor and many thousands of dollars. The cost of the computation and printing would be but a fractional part of the expenditures that have already been made. The publications of the bureau containing triangulation and precise-level data are issued in a form that is neither satisfactory nor economical. They met conditions that existed years ago. In order to issue the publications, in the form now most useful—that is, so that each of the State publications would contain all the data available at the time the publication was issued—would require additional computations in the Washington office of the Survey.

The instrument makers of the Survey are trained along the lines of a physicist and mechanical engineer, yet these experts, who make the most delicate instruments in the world, are in some cases paid no higher salaries than a fair clerk, and in no case as high a salary as he would receive in the Navy or Shipping Board.

One of the most conspicuous evidences of injustice is the marked discrimination against the clerks. Of the number called "clerks" in the Survey nearly half are specialists and have technical knowledge that is of the greatest value to the Government; yet the plea to have them properly designated and given just and fair salaries has thus far gone unnoticed. The request to no longer carry the $720 statutory places has been heard, but this is only a beginning, and until it is realized further in the shape of tangible action, the service must continue to suffer by resignations and inability to fill the places except with incompetent persons. There are but 43 clerks in the Survey, and during the past fiscal year 66 clerks left that service.

The bureau's valuable and highly trained copper engravers have been for years without salary increases, and now their righteous dissatisfaction is evident, and unless action is taken in their behalf the service will permanently suffer.

And so on down to the messengers and laborers. A man with ambition will not work for $1.50 or $2 per diem when he can earn $3 somewhere else in the Government service. This bureau has had to hire boys to do men's work, who on account of age and education are totally unfit to fill the positions, and with such conditions even boys will not stay long.

### Transportation of Families and Effects of Officers and Employees.

It has been very difficult in the past, owing to the small salaries we are able to pay, to secure properly qualified men to take charge of our commercial-attaché offices abroad and to conduct special investigations in the various foreign countries. One of the greatest drawbacks has been the fact that in nearly every case the men selected desire to take their families abroad, especially when they are to remain abroad for an extended period. They also often wish to take at least some household equipment. Under the present scale of salaries we are denied the services of many highly qualified men owing to their financial inability to take with them their families and effects. To meet this situation I am recommending that Congress allow $50,000 to pay the actual and necessary expenses for transporting families and effects of officers of this Department who are sent abroad on official business. It hardly seems proper to require these men to pay, out of their own pocket and from a small salary, expenses necessitated by Government business, and which would not be otherwise incurred.

### Transporting Remains of Officers and Employees Dying Abroad.

Under present conditions, if deaths occur in our force abroad, the family of the deceased would have to assume the care and expense of having the remains returned to this country. This occurs at a time when it is possible the financial affairs of the deceased are in such condition that the family would be considerably embarrassed. The State Department has a fund to provide for such expenses, and I earnestly recommend that provision be made to remove this weakness in our provision for foreign service. An estimate has been submitted to Congress covering this matter.

### Printing and Binding.

The Department's allotment of the appropriation for printing and binding for the fiscal year ended June 30, 1919, was $400,000. In addition, the allotment was credited to the extent of $23.47 for miscellaneous blank forms furnished by the Coast and Geodetic Survey to the Chief of Engineers, War Department, thus increasing the amount to $400,023.47. Of this sum $399,961.32 was expended, leaving an unused balance on June 30 of $62.15. From allotments made to the Department from the national security and defense fund there was expended for printing and binding the sum of $5,573.96. The increase in expenditures in 1919, compared with 1918, was $10,583.04 (or 2.68 per cent), the expenditures in 1918 being $394,952.24.

During the decennial census period of three years beginning July 1, 1919, the Bureau of the Census will not participate in the Department printing and binding allotment, as the work for that bureau, including the cost of completing operations on its work remaining unfinished at the close of the fiscal year 1919, will be paid for from the appropriation for the Fourteenth Census. The estimated cost of unbilled and uncompleted work of the Department, exclusive of that of the Bureau of the Census, at the Government Printing Office on July 1, 1919, and chargeable against the allotment for 1920, was $27,117.40, while such work at the Government Printing Office on the same date in 1918 actually cost $43,615.41. Including the work of the Bureau of the Census, the figures for this item for the past two years are as follows: 1919, $64,994.75; 1918, $74,882.95. There was also at the Government Printing Office at the close of the year work for the Department chargeable against the national security and defense fund estimated to cost $23,266.89.

During the fiscal year 1919 the Department issued on the Public Printer 2,460 requisitions for printing and binding, compared with 2,871 during the preceding fiscal year, a decrease of 411. Of the requisitions issued in 1919 there remained at the close of the fiscal year 174 on which deliveries of completed work had not been made, compared with 501 in 1918, 416 in 1917, 379 in 1916, 436 in 1915, 355 in 1914, and 344 in 1913.

The following table shows the cost of printing and binding for each of the bureaus, offices, and services of the Department during the fiscal years 1918 and 1919, together with the increase or decrease for each bureau, office; and service and the estimated cost of the work on hand but not completed June 30, 1919:

| Bureau, office, or service. | Cost of work. | | Increase (+) or decrease (−). | | Estimated cost of work not completed June 30, 1919. |
|---|---|---|---|---|---|
| | 1918 | 1919 | Cost. | Per cent. | |
| Office of the Secretary (Secretary, Assistant Secretary, Solicitor, Chief Clerk, and Division of Publications) | $18,388.96 | $17,112.36 | −$1,276.60 | − 6.94 | $351.16 |
| Appointment Division | 651.23 | 645.34 | − 5.89 | − .90 | ............ |
| Disbursing Office | 564.78 | 1,101.97 | + 537.19 | +95.11 | ............ |
| Division of Supplies | 202.55 | 344.32 | + 141.77 | +69.99 | 58.22 |
| Bureau of the Census | 96,487.31 | 113,971.18 | +17,483.87 | +18.12 | 37,877.35 |
| Coast and Geodetic Survey | 45,610.93 | 30,607.79 | −15,003.14 | −32.89 | 6,456.30 |
| Bureau of Fisheries | 15,364.28 | 12,393.97 | − 2,970.31 | −19.33 | 1,738.70 |
| Bureau of Foreign and Domestic Commerce | 118,617.02 | 120,198.30 | + 1,581.28 | + 1.33 | 13,417.94 |
| Bureau of Lighthouses | 18,586.42 | 16,595.33 | − 1,991.09 | −10.71 | 191.13 |
| Lighthouse Service | 6,443.32 | 7,580.02 | + 1,136.70 | +17.64 | 44.55 |
| Bureau of Navigation | 12,902.86 | 16,856.98 | + 3,954.12 | +30.65 | 109.93 |
| Shipping Service | 3,440.45 | 5,835.92 | + 2,395.47 | +69.63 | 170.84 |
| Radio Service | 447.29 | 635.44 | + 188.15 | +42.06 | ............ |
| Bureau of Standards | 35,638.74 | 32,548.55 | − 3,090.19 | − 8.67 | 3,288.95 |
| Office of the Supervising Inspector General, Steamboat-Inspection Service | 1,760.34 | 1,187.98 | − 572.36 | −32.51 | ............ |
| Steamboat-Inspection Service | 9,795.13 | 13,192.28 | + 3,397.15 | +34.68 | 316.00 |
| Customs Service | 10,050.63 | 9,153.59 | − 897.04 | − 8.93 | 973.68 |
| Total | 394,952.24 | 399,961.32 | + 5,009.08 | + 1.27 | [a] 64,994 75 |
| Expenditures chargeable against allotments from the national security and defense fund: | | | | | |
| Waste-Reclamation Service | ............ | 684.20 | + 684.20 | +100.00 | ............ |
| Industrial Cooperation Service | ............ | 4,854.43 | + 4,854.43 | +100.00 | 10,000.00 |
| Industrial Board | ............ | 35.33 | + 35.33 | +100.00 | ............ |
| Import and export statistics | ............ | ............ | ............ | ............ | 13,266.89 |
| Total | ............ | 5,573.96 | + 5,573.96 | +100.00 | 23,266.89 |
| Grand total | 394,952.24 | 405,535.28 | +10,583.04 | + 2.68 | 88,261.64 |

[a] Of this amount $37,877.35 is for work ordered by the Bureau of the Census, which will be paid for from the appropriation for the Fourteenth Census and will not be chargeable against the Department's allotment for printing and binding for 1920.

The amount and cost of each class of work during the fiscal years 1918 and 1919 are shown in the following statement:

| Class. | 1918 | 1919 | Increase (+) or decrease (−). | |
|---|---|---|---|---|
| | *Number.* | *Number.* | *Number.* | *Per cent.* |
| Blank forms | 25,605,702 | 25,801,745 | + 196,043 | + 0.77 |
| Reports, pamphlets, etc | 4,560,340 | 3,601,129 | − 959,211 | − 21.03 |
| Letterheads | 3,360,000 | 3,464,000 | + 104,000 | + 3.10 |
| Envelopes | 58,000 | 4,324,500 | +4,266,500 | +7,356.03 |
| Circulars, summaries, and notices | 1,562,625 | 236,700 | −1,325,925 | − 84.85 |
| Index cards | 1,318,500 | 1,706,700 | + 388,200 | + 29.44 |
| Guide cards and folders | 431,817 | 265,700 | − 166,117 | − 38.47 |
| Memorandum sheets | 2,240,000 | 2,630,000 | + 390,000 | + 17.41 |
| Blank books | 24,578 | 69,629 | + 45,051 | + 183.30 |
| Miscellaneous books (binding) | 2,819 | 2,288 | − 531 | − 18.83 |
| | *Cost.* | *Cost.* | *Cost.* | *Per cent.* |
| Blank forms | $52,441.17 | $58,650.45 | +$6,209.28 | + 11.82 |
| Reports, pamphlets, etc | 305,761.33 | 305,279.76 | − 481.57 | − .16 |
| Letterheads | 5,380.60 | 6,253.41 | + 872.81 | + 16.22 |
| Envelopes | 146.97 | 1,754.21 | + 1,607.24 | +1,093.58 |
| Circulars, summaries, and notices | 4,083.13 | 1,703.62 | − 2,379.51 | − 58.28 |
| Index cards | 1,153.60 | 2,167.73 | + 1,014.13 | + 87.91 |
| Guide cards and folders | 2,779.80 | 1,792.98 | − 986.82 | − 35.50 |
| Memorandum sheets | 2,122.46 | 1,832.86 | − 289.60 | − 18.18 |
| Blank books | 14,348.41 | 20,022.95 | + 5,674.54 | + 39.55 |
| Miscellaneous books (binding) | 6,055.63 | 5,116.37 | − 939.26 | − 15.51 |
| Miscellaneous | 679.14 | 960.94 | + 281.80 | + 41.49 |
| Total | 394,952.24 | 405,535.28 | +10,583.04 | + 2.68 |

The following table summarizes the publication work of each bureau of the Department for the fiscal years 1918 and 1919:

| Bureau or office. | Publications. | | Pages. | | Copies printed for Department. | | Cost.[a] | |
|---|---|---|---|---|---|---|---|---|
| | 1918 | 1919 | 1918 | 1919 | 1918 | 1919 | 1918 | 1919 |
| Office of the Secretary | 70 | 82 | 2,860 | 2,212 | 231,050 | 964,350 | $6,909.31 | $12,947.92 |
| Bureau of the Census | 83 | 49 | 4,528 | 17,282 | 427,875 | 215,350 | 73,150.95 | 86,301.14 |
| Coast and Geodetic Survey | 55 | 40 | 5,378 | 3,458 | 93,600 | 88,050 | 37,775.82 | 26,927.71 |
| Bureau of Fisheries | 91 | 65 | 2,852 | 1,808 | 981,840 | 159,350 | 13,833.18 | 6,014.94 |
| Bureau of Foreign and Domestic Commerce | 544 | 554 | 16,372 | 17,519 | 2,235,850 | 2,368,900 | 107,359.38 | 114,848.02 |
| Bureau of Lighthouses | 100 | 93 | 3,517 | 2,910 | 309,050 | 327,650 | 19,129.80 | 16,521.10 |
| Bureau of Navigation | 16 | 8 | 1,576 | 2,047 | 22,065 | 25,025 | 12,435.29 | 15,097.34 |
| Bureau of Standards | 158 | 104 | 4,591 | 5,169 | 238,950 | 215,150 | 23,154.69 | 19,180.87 |
| Steamboat-Inspection Service | 24 | 21 | 970 | 886 | 263,900 | 274,900 | 6,634,33 | 8,600.85 |
| Total | 1,141 | 1,016 | 42,644 | 53,291 | 4,804,180 | 4,638,725 | 300,382.75 | 306,440.49 |
| Services for which expenditures were chargeable against allotments from the national security and defense fund: | | | | | | | | |
| Waste-Reclamation Service | ...... | 2 | ....... | 39 | .......... | 60,000 | .......... | 633.05 |
| Industrial Cooperation Service | ...... | 1 | ....... | 408 | .......... | 3,000 | .......... | 4,822.70 |
| Total | ...... | 3 | ....... | 447 | .......... | 63,000 | .......... | 5,455.75 |
| Grand total | 1,141 | 1,019 | 42,644 | 53,738 | 4,804,180 | 4,701,725 | 300,382.75 | 311,896.24 |

[a] Figures relate to publications actually delivered to the Department during the year; consequently they do not agree with similar figures in a preceding table giving the cost of work done by the Government Printing Office during the fiscal year. Frequently the cost of a publication is charged against allotments for two or more fiscal years.

More than 75 per cent of the allotment for printing and binding for the Department is expended for publications of various kinds, and to keep such expenditures within due bounds careful editing and preparation of manuscripts are necessary. This work requires not only long experience and careful training, but a certain degree of natural aptitude on the part of editorial clerks. Owing to the limited salaries available, it has not always, or even as a rule, been possible to procure and retain the best talent in this line. A great deal has been accomplished, however, by the Department's editorial clerks, whose knowledge of matters having to do with the production of books has resulted in many economies. At the same time much attention has been given to the matter of improving the character of publications.

The volume of work now devolving on the few editorial clerks in the Division of Publications is so great that all of it can not possibly be given the attention that it requires. Every folio of manuscript should be carefully read, edited, and prepared before being forwarded to the Government Printing Office, and every proof should be revised as carefully before being returned to the printer. To do this work properly would require several additional clerks, and the Department's personnel estimates for 1921 will include an increase in the editorial and proof-reading force of the division. It is believed that the results would abundantly justify the increased expenditure.

The Department issues annually, with monthly supplements, a pamphlet containing a complete list of its publications available either for free distribution by the Department or by purchase from the Superintendent of Documents. The free distribution of many of the publications of the Department is limited, the miscellaneous distribution being made through the Superintendent of Documents on a sales basis. On January 1, 1919, under special authority of Congress (sec. 4, act of June 20, 1918), the light and buoy lists issued by the Bureau of Lighthouses were placed on a sales basis, the free distribution being confined to official uses.

The following statement gives the number of copies of the publications of the Department sold by the Superintendent of Documents during 1918 and 1919 and the amount received from such sales:

| Sales. | Copies. | | Receipts. | |
|---|---|---|---|---|
| | 1918 | [a] 1919 | 1918 | [a] 1919 |
| By annual subscriptions | 2,884,213 | 2,478,186 | $15,921.04 | $19,451.20 |
| Through miscellaneous sales | 90,047 | 116,465 | 16,965.75 | 23,099.74 |
| Total | 2,974,260 | 2,594,651 | 32,886.79 | 42,550.94 |

[a] Preliminary figures.

Coast pilots, inside route pilots, tide tables, and charts are sold by the Coast and Geodetic Survey, receipts from these sales being $24,620.71 in 1919 and $20,194.19 in 1918. Thus, the total receipts from sales of publications of the Department was $67,171.65 in 1919 and $53,080.98 in 1918.

During the last fiscal year 3,800,503 publications and printed circulars of the Department were distributed to the public through the Division of Publications, compared with 3,863,594 during the fiscal year 1918.

There were received and acted on during the year 57,738 requests for 419,689 copies of publications, compared with 61,538 requests for 568,703 copies in 1918.

Mailing lists for use in sending typewritten or multigraphed information, as well as publications, are maintained by the Department. On July 1, 1919, there were 349 of such lists, containing 285,928 names.

During the year the Department expended $2,969.21 for advertising for proposals for furnishing supplies of various kinds, for construction work, and for the purchase of condemned property.

### "International Price Comparisons" Publication.

The War Industries Board had compiled valuable information on the subject of international price comparisons, but about the time this data was in such shape that it was ready for publication the board ceased to exist. The Department published it under the above title, in view of its importance to the commerce and industry of the country.

### Motor-Vehicle Equipment.

The motor-vehicle equipment of that part of the Department in the Commerce Building has been increased by one 500-pound truck for light hauling and special-delivery work.

The following table shows the operation data for the fiscal year 1919 relating to this equipment:

| | 500-pound truck. | 1,500-pound truck. | 2,000-pound truck. | 1-cylinder motor cycle. | 2-cylinder motor cycle. |
|---|---|---|---|---|---|
| Mileage | 5,743 | 8,617 | 11,504 | 3,098 | 1,000 |
| Operating days | 168 | 301 | 288 | 129 | 43 |
| Average miles per diem | 34.18 | 28.63 | 39.94 | 24.02 | 23.26 |
| Gasoline consumption (gallons) | 438 | 967 | 1,342 | 80 | 55 |
| Miles per gallon of gasoline | 13.11 | 8.91 | 8.57 | 38.73 | 18.18 |
| Cylinder-oil consumption (gallons) | 12.88 | 63.19 | 71.56 | 6.31 | 1.13 |
| Miles per gallon of oil | 445.89 | 136.37 | 160.76 | 490.97 | 884.96 |

**Stock and Shipping Section.**

There were received and filled by the stock and shipping section during the year 7,079 requisitions for supplies of all kinds, of which 2,918 were for the offices and bureaus of the Department located in Washington and 4,161 were for the outside services. Of the total number of requisitions received 1,896 were for blank forms, 551 were for printed stationery, and 4,632 were for miscellaneous stationery supplies.

Filling the 4,161 requisitions for the outside services required the packing and shipping of 6,457 pieces, weighing 201,438 pounds, or nearly 100¾ tons, of which 4,957 pieces, weighing 112,026 pounds, were sent by ordinary mail, 214 pieces, weighing 1,363 pounds, were sent by registered mail, and 1,286 pieces, weighing 88,049 pounds, were sent by freight or express.

The following table shows the number of books and blanks sent to each of the outside services during the year:

| Service. | Blank books. | Blank forms. |
|---|---|---|
| Customs Service (Bureau of Navigation and Foreign and Domestic Commerce). | 9,474 | 1,805,801 |
| Fisheries Service | 204 | 509,417 |
| Lighthouse Service | 11,652 | 772,931 |
| Bureau of Navigation: | | |
| Shipping Service | 11,026 | 230,960 |
| Radio Service | 257 | 116,205 |
| Steamboat-Inspection Service | 216,761 | 653,183 |
| Miscellaneous | 418 | 164,255 |
| Total | 249,792 | 4,252,752 |

The following statement gives the quantity of each class of printed stationery supplied during the year:

| | | | |
|---|---|---|---|
| Letterheads | 855, 500 | Blank forms | 383, 672 |
| Memorandum sheets | 2, 936, 000 | Index cards | 1, 572, 400 |
| Embossed letterheads | 7, 500 | Guide cards | 179, 150 |
| Stenographers' notebooks | 3, 676 | Vertical folders | 75, 300 |
| Blank books | 6, 702 | Continuation sheets | 497, 000 |

**Department Library.**

The activities of the Department's library included the acquisition of 2,244 bound volumes and 562 pamphlets, compared with 3,396 volumes and 926 pamphlets for the previous year. In addition, about 1,500 books were carded and filed.

Duplicates disposed of numbered 2,250 and 574 books were borrowed from the Library of Congress and other libraries. Weekly and monthly periodicals were currently received, recorded, and sent to divisions of the various bureaus. The reference work is increasing daily and the library is in constant use by the bureaus.

During the year the library has been of great assistance to other departments and Government establishments in connection with research work incident to war activities.

**Division of Supplies.**

The Division of Supplies handled 2,787 requisitions during the year, and the clerical work in connection therewith included the writing of 4,446 orders and 7,040 invoices, and the issuance of 2,158 sets of proposals. Supplies ordered through the division during the fiscal year reached a total value of $198,361.85, and 4,324 vouchers were audited for payment.

Receipts from the sale of old and condemned furniture, office equipment, and miscellaneous other property of no other use to the Department amounted to $216.08.

The cost of the 273 new typewriters purchased during the year was $18,124. Deducting the allowance on old machines of $2,218.50, shows a total net cost of $15,905.50, and an average of $58.26 each.

**State Fair Exhibits.**

This Department's participation in a joint Government exhibit for the summer and fall State fairs was necessarily restricted through lack of any fund from which expense of preparing exhibits could be paid. The agricultural appropriation bill provides a fund for exhibit work, but this fund is limited entirely to that Department. However, the Bureaus of Standards, Fisheries, and Lighthouses, the Coast and Geodetic Survey, and the Steamboat-Inspection Service contributed such material as was in their possession. Because of the unusual educational value of such activities, appropriation should be made for real work along this line.

**Liberty Loans.**

The employees of the Department have done their part nobly and patriotically toward financing the war. The number of subscribers and the total subscriptions for each loan are shown in the following table:

| | Subscribers. | Subscriptions. |
|---|---|---|
| First Liberty Loan | 2,516 | $500,850.00 |
| Second Liberty Loan | 3,377 | 604,700.00 |
| Third Liberty Loan | 4,793 | 607,550.00 |
| Fourth Liberty Loan | 5,829 | 883,650.00 |
| Victory Liberty Loan | 4,607 | 846,050.00 |
| Total in bonds | | 3,442,800.00 |
| War Savings and Thrift Stamps | | 115,430.03 |

The sales of War Savings and Thrift Stamps cover a period of 18 months, January 1, 1918, to June 30, 1919. The stamps are being regularly purchased by the employees, there being well-organized committees in each bureau to handle and promote their sale.

**Contributions.**

The employees contributed liberally during the year to the numerous drives for the Red Cross, United War Work Campaign, Relief in the Near East, the Victory Memorial Building, and other worthy and patriotic causes.

**Employees' Relief Association.**

On April 16, 1919, the U. S. Department of Commerce Immediate Relief Association was organized, its object being to make immediate payment in cash to the family on the death of a member.

Two death benefits have already been paid, both within an hour after notification of death, and the relief furnished was prompt and substantial.

**Purchase of Dutch Harbor, Alaska.**

I renew the recommendation made in my reports for 1915, 1916, 1917, and on page 44 of my report for 1918, that the Government should purchase Dutch Harbor, the abandoned village of the North American Commercial Co. in Alaska.

**Abolition of the Official Register.**

The recommendation made on page 44 of my annual report for last year, for the abolition of the the Official Register, provided for by House bill 2354, is renewed. This publication represents a waste of paper and labor, since the purpose for which it was intended is no longer served by it. The card system for which the measure provides would be less expensive and far more efficient.

**Work of the Solicitor's Office.**

During the fiscal year ended June 30, 1919, 217 contracts, totaling $1,541,221, together with 18 contracts of indeterminate amounts; 91 leases, amounting to $423,938; 20 revocable licenses amounting to $3,801; 2 deeds in the sum of $3,305; 108 contract bonds, amounting to $323,796; 115 official bonds, amounting to $590,500; and insurance policies amounting to $137,400 were examined (approved, disapproved, drafted, redrafted, or modified).

The number of legal opinions rendered, formal and informal (memorandum), totaled 258. Legislative matters handled, which concern the Department of Commerce (drafting and redrafting of bills, reports relative thereto, etc.) numbered 366. In addition, 1,534 miscellaneous matters, embracing everything submitted for the advice or suggestion of the Solicitor, or for the formulation of departmental action, not included in the foregoing items, were handled by this office.

**Development of Waterways.**

I renew the suggestion that every economic, military, and naval argument urges the earliest possible development of a Government-owned waterway connecting all the great cities of our Atlantic seaboard with one another, with the New York State waterways reaching to the Great Lakes and Lake Champlain, and with all the railroad terminals along our eastern coast.

An important step forward in this connection has been the beginning of condemnation proceedings for acquiring the Cape Cod Canal. This was done, pursuant to the act of Congress

(Public No. 37, 65th Cong.) approved August 8, 1917, which provided that the Secretary of War, the Secretary of the Navy, and the Secretary of Commerce should examine and appraise the value of the works and franchises of the Cape Cod Canal with reference to the advisability of the purchase of the canal. The Secretary of War was authorized, if all the Secretaries mentioned were in favor of the acquisition, to enter into negotiations for its purchase. The three Secretaries having concurred in a recommendation that the purchase was desirable, the Secretary of War caused condemnation proceedings to be begun on January 30, 1919. Bills are now pending (S. 2083 and S. 862), providing for the acquisition and operation of the canal by the Government, which have been approved by this Department.

It remains to recite the brief but effective service of several branches of the Department's work undertaken during the fiscal year which have ceased to exist.

**Industrial Board.**

The Industrial Board of the Department of Commerce was organized with a view to expediting the process of commercial readjustment. When it was formed prices were in a state of flux. The general expectation in the business world was that prices were, in the near future, to fall and every one hesitated to purchase lest they should buy upon a falling market.

It was a voluntary organization of business men composed of seven members, three representing, respectively, the Railroad Administration, the Department of Commerce, and the Department of Labor, and four representatives of industry. Under the then existing circumstances the board undertook to promote general confidence and hasten the revival of trade by securing the voluntary assent of industries to reductions in prices which were to be such, however, as did not involve either reducing the wages of labor or closing down those individual factories whose efficiency was not as great as the larger ones and who were generally known as "high-cost producers."

The board succeeded in obtaining the assent of the steel industry and of other considerable industries, and marked reductions in prices of steel were announced and recommended to the Government purchasing departments. From these recommendations the Railroad Administration dissented, thinking the prices recommended too high. The final refusal of the Railroad Administration to accept the recommendations of the board resulted in the resignation of the board, which ceased to exist on May 9, 1919. The reduced prices which have been arranged with other industries were never promulgated for this reason. Since then the Railroad Administration has purchased (under protest) steel rails at the prices recommended by the board.

## Industrial Cooperation Service.

On January 1, 1919, the Industrial Cooperation Service was formed to take over certain peace-time functions of the War Industries Board. Your approval on December 3, 1918, of my request for $100,000 from the fund for the national security and defense made it possible to carry on this work during the last six months of the fiscal year. While some of the work had been developed by the War Industries Board, it was carried on there in a restrictive and administrative way, while the Industrial Cooperation Service's policy was promotive and cooperative.

Generally speaking, the Service established a focal point in the Government for the discussion of business and industrial problems. As the work progressed the problems fell within well-defined classes; i. e., those concerned with the standardization of products; those concerned with the search for outlets for waste products and the commercial development of new products; and those concerned with plans for minimizing business abuses. It also acted for this Department with other Government departments in the consideration of industrial matters.

The Service was asked in numerous different cases to seek outlets for by-products or waste products of various industries. The most striking example was the development of the uses of cottonseed-hull fiber, hitherto practically a waste product of the cottonseed-oil industry. Three uses for the fiber were developed: (1) As an insulator for fireless cookers, incubators, etc.; (2) as a binder in the manufacture of composition soles for shoes; (3) as a material for making paper.

It also found an outlet for cotton linters, used so extensively during the war. Cooperating with the War Department, the Bureau of Standards of this Department, and the Forest Products Service of the Department of Agriculture, this Service demonstrated that linters could be used to make a good grade of book paper, and a number of mills have started to work along these lines.

At the request of the Secretary of State this Service investigated the possibilities of starting a submarine telegraph-cable industry in the United States. The reports of the Service were valuable in the consideration of the proposed Government trans-Pacific cable, provided for in Senate bill 1651. One of the important duties of the Industrial Cooperation Service was cooperation with business organizations in formulating plans for minimizing what are known as "trade abuses." At the request of the publishers of books and the National Credit Men's Association the "returned-goods" question was studied. The lowest estimate ever made as to the cost to American business of the unjustifiable return of merchandise was $25,000,000 annually. This loss, of course, is borne by the ultimate purchaser. The Book Publishers' Association's problems were treated to the satisfaction of all concerned. The larger general problem of the unjustifiable return of merchandise had to be dropped in its early stages because Congress did not appropriate money for the continuance of this Service.

In every instance the assistance rendered by this Service was requested by the industry or business concerned and its activities embraced many fields. The Service provided an admirable place in the Government where business men could come and discuss their difficulties and be assured of sympathetic attention. The refusal of Congress to provide the sum of $56,000 for the continuance of this productive organization necessitated the conclusion of its activities on June 30, 1919.

**Waste-Reclamation Service.**

Organized to meet a vital war emergency, resulting from a shortage of war materials, the Waste-Reclamation Service rendered very valuable permanent service during its short existence, in beginning the campaign of education necessary to get the American people in the habit of saving the many things that they have been throwing away. Its chief function was that of education, the action resting with the State and subdivisions thereof, as the advantage accrued to them. Through speeches, publications, and specific advice by letter when so requested, and all the other means open in matters of this kind, this Service sought to aid in the reclamation of waste inorganic materials. By the proper disposal of ashes, garbage, etc., by the communities, not only the materials themselves would be made of use again, but there would be a surplus of money receipts that would reduce taxes proportionately.

The system of disposing by public sale of unused war materials, now being used, was suggested by this Service. Through its initiation and efforts a drive was launched, in conjunction with the Treasury Department, for the saving of materials usually destroyed in the annual clean-up compaign, and payment made therefor in Government Thrift Stamps rather than cash. The Salvage Division of New England estimated that $250,000 worth of Thrift Stamps would be dispersed by this method during the months of May and June.

A new method of handling waste tin cans was also investigated and called to the attention of the country. The old system of handling these cans emphasized the redemption of the tin removed from the can, while the new system deheads the can and uses the tin in a flat form. Besides reducing the cost of handling the cans, this method increases by about 300 per cent the return to the contractor.

As a means of advising other communities how to proceed, the Akron Industrial Salvage Co. (Inc.), a community waste-saving system, was investigated and a report made covering its operation. Over 15,000 copies of the first edition of this publication were distributed in two weeks and several communities were, after looking into the subject, ready to launch similar systems when this Service had to be discontinued.

An investigation of the present means of disposing of waste paper in Government services was made through the courtesy of the Public Printer, and the report, which was published as House document 87, Sixty-sixth Congress, first session, showed that in the year 1918 the Government should have received at least $86,869.35 more for its waste paper than under the contract price. The report also made definite recommendations which, if carried out, would secure from $50,000 to $100,000 annually additional from this source.

At the request of the Wool Stock Graders' Association this Service released to the press a statement dealing with the value of shoddy and recommended that the interested associations confer with a joint committee to be composed of representatives of the Departments of Agriculture and Commerce, with the idea of establishing tests for the evaluation of woolen fabrics. The interest shown by several organizations established the constructive value of the statement, and steps were taken to organize the joint committee. At about that time the Service had to be discontinued on account of lack of funds.

Tests were being made to determine the method for utilizing old shoes. This problem was pressing, and demanded immediate study, but also had to be discontinued.

A study of the Army system of garbage segregation as a means of elimination of waste in the preparation of food was in the course of preparation. It is believed that the Army system can be applied to all institutions. An American machine used by the British army was being studied with the idea of recommending that a machine of this type be installed in the institutions for the recovery of fat.

A training course for salvage managers had been outlined and one institution was prepared to institute such a course as soon as this Service had developed the field. Plans for the development of an association of salvage managers had been drawn up and submitted to several leaders in this field for consideration.

The refusal of Congress to appropriate $25,000 in order that this productive work might be carried on necessitated the disbanding of the Service on June 30, 1919. It will be noted that in one item alone—the study of conditions governing the disposal of waste in the Government Printing Office—a saving of from $50,000 to $100,000 per annum could have been made, which would have paid the cost of the entire Service for two years.

**Introduction of New Fish Food by the Bureau of Fisheries.**

It seems most extraordinary that at this time of high prices for all matters entering into the cost of living, and when urgent pressure is being exerted to add, because of sore need, to the animal food supply of the world, a work which was successfully developing large quantities of unused, nutritious, and cheap foods should be deliberately cut off.

It is, therefore, with deep regret on behalf of many thousands of our population living in crowded centers along the Atlantic, Pacific, and Gulf coasts and on the shores of the Great Lakes, that I saw the refusal of Congress to grant the sum of $15,000 to maintain the small but effective staff of our persons that have been successfully engaged in the work of introducing new, abundant, and cheap fish foods, available in large quantities, but either unused or little used. Such fishes, for example, as the Pacific mackerel, the ordinary cod, and the so-called black cod, or sable fish, in the same ocean, find as yet a limited market. The same is true of burbot and the bowfin of the Great Lakes, and of the whiting of the Atlantic. There are many others. It appears to have been the case that this productive work, having begun during the war, was assumed to be strictly war work, whereas the daily evidence to every housewife in the land of the price she must pay for food is itself witness that the continuance of this work is needed.

It is difficult for me to understand the mental processes whereby so small a sum as $15,000 was refused for so great a work and one that bore so directly upon the homes and happiness of many times ten thousand people who feel the pressure of current prices. The work had received nothing but praise, which was well deserved. Economy of the sort which stops an effort to bring cheap and abundant food to the knowledge of our people, and forces them, without this knowledge, to buy high-priced foods, is of a curious type.

The matter was brought by me personally before the Appropriations Committees of both the House of Representatives and the Senate, and its peculiar importance at this time was urged upon them, but in both cases without success. Feeling, however, that the subject could not have been fully understood, it was brought before the attention of the House of Representatives by a letter dated July 19, 1919, which forms House Document No. 155, Sixty-sixth Congress, first session, and is printed in full, with inclosures, in an Appendix B to this report, in connection with the discussion of another subject. Subsequent to this the matter was again brought before the Appropriations Committee of the House of Representatives by the Commissioner of Fisheries on September 2, 1919. No appropriation, however, has been made.

One is at a loss to understand the reasoning, if it be such, which leads to cutting off three productive services at a time when their results were effectively helping the solution of a concededly difficult situation. The Industrial Cooperation Service was not an expense to the country, neither was the Waste-Reclamation Service, still less the food demonstration work of the Fisheries Service. On the contrary, these three Services produced wealth. The country was the richer for every month in which they operated. The country is poorer for their stoppage. There is less food to-day available because the Fisheries demonstration work has ceased. Products that are valuable are being wasted in great quantities and values because the Waste-Reclamation Service no longer exists. For lack of the Industrial Cooperation Service production now so sorely needed is, in many places, either delayed or hampered or rendered more expensive for lack of the mutual, helpful touch that Service provided. There is no doubt of these facts. They are denied by no one.

The psychology seems to have been that anything that was born during the war was warlike, in its nature unfitted for peace, extravagant. No discrimination seems to have been made in favor of services which, coming into existence during the war, yet were meant for peace. The besom of destruction was laid upon them. They have been destroyed without regard to their productiveness or their advantage to the country.

This, naturally, leads to the suggestion that Congress makes no difference between productive and unproductive services. It does not practically recognize the difference between expenditure and investment. It adds no force, so far as my experience goes, to demonstrate that the money expended in one case produces a direct profit to the Nation as a whole. It is all treated as expense alike. It is all regarded as something to be cut away, if it be possible, and men who have by careful forethought developed services to a self-sustaining basis are discouraged to find that their efforts not only bring no thanks or appreciation, but that, if the facts concerning them are not disbelieved, they are at least ignored.

Just as the system which Congress uses in dealing with unexpended balances is calculated to promote, and does, in fact, promote, the avoidance of such balances by the deliberate spending at the close of the fiscal year of all available balances for any proper use, so the failure to discriminate between productive and unproductive services directly encourages looseness of administration and leads men to become careless as to whether their work is profitable or not.

The public in no small measure takes its mental cue from the attitude of Congress, reflected through the press, and assumes all Government appropriations to mean expense, and would be surprised to learn the extent to which many of them are profitable investments. The motor-vessel fleet of the Bureau of Navigation, of the Department of Commerce, costs the Government nothing; instead it has turned into the Treasury, through mitigated fines, a sum sufficient to pay the original cost of the motor vessels and their maintenance, with a surplus. The Bureau of Navigation tself gathers, through the medium of the collectors of customs, navigation taxes which far more than cover its entire outlay.

The value at current cash prices of the fish rescued by the seining parties of the Bureau of Fisheries from the overflowed ponds of the Mississippi River between St. Paul and New Orleans is more than sufficient to pay the entire expense of maintaining the 52 fish hatcheries of that service and to present their entire work of producing over seven billion small fish and fish fry per annum as a clean gift to the Nation, free of all expense.

In an industrial corporation the outlook is always toward the productiveness of expenditure; in the Government services the productiveness of the expenditure is almost or quite ignored. It may be said, indeed, that the assumption is that all the services are deemed to return to their value in work, else they would not be permitted to exist. If this be so, what shall be said in favor of those services which not only do return their value in work, but in so doing return into the Treasury in cash more than their cost of operation? These, under private management, would be deliberately and necessarily encouraged. These, under public management, are, so far as my experience goes, given no special consideration.

## BUREAU OF FOREIGN AND DOMESTIC COMMERCE.

(PHILIP B. KENNEDY, *Director*.)

The decisive factor in the work of the Bureau of Foreign and Domestic Commerce during the fiscal year 1919 was the signing, on November 11, of the armistice between Germany and the allied powers. By that event the year was divided into two distinct periods characterized by divergent aims. It may be said with truth that the termination of hostilities in Europe altered, as by an abrupt shock, the aspect of the commercial world and the trend of all activities in trade promotion. With the achievement of the great goal, tremendous forces were immediately relaxed, recently created mechanisms were divested of their purpose, and the need arose for diverting to new channels the energies that had been devoted to the winning of the war.

While the armies were still struggling on the western front, private interests were subordinated to the national cause. Trade regulations and restrictions that ordinarily would have been considered shackling were met in a spirit of willing sacrifice. Under circumstances such as these the Bureau of Foreign and Domestic Commerce aided in every possible way the war organizations of the Government and recognized that its researches in foreign markets should be considered as preparation for the change that would inevitably come with the laying down of arms.

The conclusion of the armistice produced a striking change. Dangerous sea lanes became safe again. Artificial economic barriers were gradually let down. New States arose, with freedom of entrance for the investigator and the salesman. In Europe "reconstitution" became the potent word. Provinces had been devastated; industries had been wrecked; the whole normal course of existence had been warped or stifled or turned to alien ends. There was the menace of starvation. Stocks were depleted. Machinery that had supplied the wants of millions lay in twisted heaps of useless rubbish. And, for replenishment, the nations which had suffered looked to the United States. Here, then, was a situation representing at once commercial opportunity and social duty. To Europe the Bureau of Foreign and Domestic Commerce has sent many men to study the needs of the people and the best means of satisfying them.

Since the armistice American producers have been free to resume their trade in South America, the Far East, the Near East, and the many countries where the war emergency had involved a slackening of our effort, and a further incentive is given by the urgent desirability of providing new outlets for the manufacturing facilities called into being by the war. As the industries of the war-racked European nations revive—as adjustments are effected and secure economic bases are evolved—those nations will reach out beyond the seas to find markets for their wares.

American exporters will find their path no easy one. They will need the firmest resolve, the most efficient methods, and, above all, the most accurate knowledge. This knowledge it is the function of the Bureau of Foreign and Domestic Commerce to supply. American producers should not enter new fields in any groping or hesitant way; they must be equipped with information as comprehensive as it is practical, as pertinent as it is sound. In the gathering and disseminating of such essential facts, the Bureau is proving signally useful to American business. Its aim is to stimulate, to vitalize, and, with patience and continuous application, to smooth the way for export trade. It is expanding and driving ahead with a clear comprehension of the object sought. Its present opportunity is remarkable; and it may be expected to respond with effective service.

### Unprecedented Totals for American Foreign Trade.

During the fiscal year 1919 new high marks were established for both the import and the export trade of the United States. Imports of merchandise totaled $3,095,876,582, as compared with $2,945,655,403 in 1918 and $2,659,355,185 in 1917. Domestic exports amounted to $7,074,011,529, as against $5,838,652,057 in 1918 and $6,227,164,050 in 1917. Not considering reexports of foreign goods, the visible balance of trade in favor of the United States on merchandise transactions for the year just ended was $3,978,134,947, a figure never approached in the commerce of any nation in the history of the world.

The exports of domestic and foreign merchandise to the several grand divisions during the fiscal year 1919 were as follows: Europe, $4,634,816,841; North America, $1,291,932,342; South America, $400,901,601; Asia, $603,924,548; Oceania, $208,351,493; Africa, $85,157,432, making a total of $7,225,084,257.

### Letters of Appreciation Show Practical Results Accomplished.

That the services of the Bureau of Foreign and Domestic Com merce have contributed appreciably to the great growth of American trade with all parts of the world is shown by the many unsolicited letters of commendation received—communications telling of large sales effected through the bureau's aid, mentioning the receipt of data satisfying specific needs, and expressing gratification at the essentially practical and productive character of the work performed. And it is to be remembered in this connection that the concrete results brought directly to the bureau's attention doubtless represent only a small fraction of the trade development that may fairly be attributed to its efforts.

### Period of Readjustment in Commercial-Attaché Service.

The bureau's commercial-attaché service the past year has undergone a period of readjustment. War work continued up to the signing of the armistice, while immediately thereafter plans were made for the resumption of the normal activities of trade promotion and investigation. The readjustment period, however, brought its own special problems. For example, in Argentina, Brazil, Japan, and Australia the representatives have been busy with the difficulties involved in the sudden arrival of goods far in excess of immediate needs. Through their efforts the situation was handled effectively without loss to importers, exporters, or bankers. In England, France, Italy, Spain, the Netherlands, and Denmark the attachés have had to deal with questions arising out of the relaxation and modification of war-time trade restrictions.

An important development in connection with the commercial-attaché service was the sending out of trade commissioners to conduct general investigations under the direction and supervision of the commercial attachés. Early in the fiscal year Herman G. Brock was sent to London to assist Commercial Attaché Kennedy in carrying on the strictly commercial activities that were necessarily being pushed aside by the war work. Mr. Brock furnished the bureau with timely reports and was also able to assist Mr. Kennedy materially.

Shortly after the armistice the Department of Commerce recognized the necessity for a greatly increased force in Europe to keep in the closest possible touch with important developments and trade tendencies. The President allotted $200,000 from the fund for national security and defense, and by the latter part of February trade commissioners and clerks were dispatched to Europe.

Ten trade commissioners worked on general investigations directly under the supervision of the commercial attachés. Their investigations covered a wide variety of commercial, financial, and industrial subjects.

**Activities of Attachés in Europe.**

Coming now to a consideration of the commercial-attaché posts themselves, the London office should be mentioned first. Commercial Attaché Philip B. Kennedy was engaged in war work in addition to the normal activities of his office. Besides handling mineral and tin problems for the War Trade Board and aiding the War Department in the purchase of urgently needed materials, Mr. Kennedy took over during the latter part of the year the entire handling of the Swedish iron-ore and Norwegian molybdenum contracts, for which the President put at the disposal of the Secretary of Commerce $6,000,000 from the fund for national security and defense. Mr. Kennedy has cooperated closely with the ambassador and the consul general in the matter of British import restrictions. One of the most important features of the work in London during the year was the cooperation between the office of the commercial attaché and the American Chamber of Commerce in London. The attaché was an ex officio member of the trade information committee, and his office was represented at its weekly meetings. The office in London made first-hand investigations of markets for American products. For example, the possibilities for the sale of American cottonseed-hull fiber were carefully analyzed. Through the commercial attaché American producers of dyestuffs were put in touch with officials of the Italian Government. Mr. Kennedy represented the United States unofficially at the Interallied Parliamentary Conference held in London, July 2 to 4, 1918, and submitted reports upon the deliberations of the conference. During April Commercial Attaché Kennedy returned to the United States to confer with the officials of the bureau and meet business men interested in post-war conditions in England. The customary tour of commercial centers was made and many conferences held. As a result of an invitation extended through Mr. Kennedy to the Chamber of Commerce of the United States in behalf of the Associated Chambers of Commerce in Great Britain, the former body decided to bring to this country in the early fall, for a discussion of industrial and financial reconstruction problems, commercial delegations from the allied nations in Europe. In July, 1919, Mr. Kennedy was appointed Director of the Bureau of Foreign and Domestic Commerce.

Pierce C. Williams accompanied to Paris the War Trade Board representative and, under his direction, organized and operated for several months the American office of the Interallied Contingent Commission and continued to assist, to an extent, in the work of the War Trade Board. He submitted timely and valuable reports on such subjects as French industrial reconstruction, the formation of consortiums and comptoirs, import restrictions, and cooperative selling by American interests. He made an investigation of economic conditions in Switzerland. Mr. Williams resigned to enter private employ, and Chauncey Depew Snow, formerly Assistant Chief of the Bureau, was appointed commercial attaché and took charge in Paris March 24, 1919. Mr. Snow also has kept in intimate touch with reconstruction problems. Tariff questions and changes in import restrictions have been closely followed. The attaché has cooperated with the Rhineland High Commission, the officials in charge of the sale of Army supplies and equipment, and the Supreme Economic Council, as well as with the American Chamber of Commerce. As an example of the tangible results accomplished by Mr. Snow, I may mention the assistance given to individual import applications for American goods, even to the extent of preventing the confiscation of such goods.

At the beginning of the fiscal year Commercial Attaché Erwin W. Thompson was in London, continuing the work with the War Trade Board begun in March. He returned to Copenhagen in July and resumed his intensive study of the Scandinavian and German press. This study and daily contact with commercial and financial men throughout the Baltic region enabled him to furnish authoritative reports on economic subjects. Through one of his reports the United States Shipping Board was enabled to obtain from a Danish factory large Diesel engines urgently needed. Mr. Thompson worked out plans for financing shipments of American cotton and other commodities into the new Baltic countries by a system of dividing up the credits between the American shipper and the Danish institutions in a way that keeps the American shipper always secured by safe shipping or warehouse documents. Other special activities included an investigation of textile substitutes, a study of methods to be used in reconciliation of trade disputes, a survey of Scandinavian sources of supply of foodstuffs and other products for the American Expeditionary Force, and inquiries as to the establishment of an American chamber of commerce in Copenhagen.

During the entire year Commercial Attaché Paul L. Edwards acted as the American representative on the Interallied Trade Committee at The Hague. Mr. Edwards served as the agent of the War Trade Board and the American minister in carrying out the various agreements with the Dutch Government, including the handling of the correspondence with the Netherlands Oversea Trust. During November, 1918, he visited London to confer with allied representatives regarding the various Dutch economic agreements. Several trips were made to Paris to confer with the Supreme Blockade Council concerning blockade administration and the shipping of foodstuffs to Germany under the Brussels agreement. Mr. Edwards also reported on current commercial and financial matters.

Commercial Attaché William C. Huntington spent most of the year in the United States because of the unsettled conditions in Russia. During the early part of the fiscal year he was in Moscow aiding our diplomatic and consular officers. He left Russia in the fall, reaching the United States in November after visiting Stockholm, London, and Paris. In Washington, Dr. Huntington has held many conferences with officials of other Government departments interested in Russia. Besides making numerous addresses, he has organized the Russian division of the bureau.

In the fall of 1918 it was decided to establish a commercial-attaché post at Madrid, and the position was offered to William A. Montavon, who had served in Lima, Peru. After the resignation of Mr. Montavon, Chester Lloyd Jones was appointed and opened his office March 5, 1919. At this post the work has been largely of a trade-promotive character. Mr. Jones has assisted the embassy in connection with our commercial treaty relations with Spain, and kept in close touch with proposed tariff legislation. He secured the revision of discriminating tariff classifications affecting American trade. Our ambassador in Spain has expressed his gratification at the valuable services rendered by Mr. Jones, and has recommended the assignment of additional assistants in the office of the commercial attaché at Madrid. The representations of our attaché were largely responsible for the recent granting to a New York company of the important concession for exploiting extensive potash deposits north of Barcelona. This single achievement is sufficient to justify the maintenance of the attaché's office and the expenditure it involves. Other activities worthy of special mention include assistance to the Liquidation Commission of the Army, cooperation with the American Chamber of Commerce in Barcelona, and special reports on Spanish trade conditions.

The second new post opened during the year was at Rome. Commercial Attaché Alfred P. Dennis reached his post in March, 1919. Through his efforts and those of his assistants, import permits were issued for 8,000 packages of American goods that had been held for six months at Genoa. Among other products, American tractors, shoes, hosiery, tubing, steel, and chemicals were admitted upon the representations of the attaché's office. Mr. Dennis assisted the embassy in obtaining equal treatment for American goods discriminated against in Italian treaties with other nations. He has discussed with the Director of Economic Policy and the Director of Customs questions relating to the admission into Italy of American products. He has also aided firms seeking to establish themselves in the Italian market.

### Results Attained by Far-Eastern Offices.

During the first half of the fiscal year Commercial Attaché Julean Arnold was in Shanghai, serving as chairman of the International Maritime Customs Conference. During Mr. Arnold's absence the office at Peking was in charge of A. W. Ferrin and Paul P. Whitham. In cooperation with a representative of the War Trade Board, Mr. Ferrin initiated negotiations for the sale of 5,000 cars and 100 locomotives to the Chinese Government Railways under a car-trust agreement. Mr. Arnold assisted in the organization of a new American bank in China, as well as in that of a joint Chinese-American bank. As a result of his efforts, equipment for 10 cotton mills was purchased and installed in China. He aided in establishing an American tannery, had a share in the sale of American cars and railway equipment, and aided American architects to obtain contracts in China. American industrial films have been exhibited to acquaint the Chinese business public with American equipment and methods of production. The attaché has worked for the protection of American trade-marks, and has furthered the establishment of an American news service and better shipping facilities to China. With the aid of American consular officers he has prepared a comprehensive handbook of China. Mr. Arnold is now on his way to the United States.

Up to the signing of the armistice Commercial Attaché Frank R. Rutter, at Tokyo, was chiefly engaged with problems arising out of trade restrictions and with the study of industrial and economic conditions. Dr. Rutter left for the United States in December to accept an important position on the staff of the bureau in Washington. James F. Abbott was appointed to succeed him. Since his arrival at his post in March, Mr. Abbott has been renewing contacts in Japan and has been keeping Americans acquainted with commercial developments.

In Australia, A. W. Ferrin, by addresses before commercial bodies and through press contributions, has aided in removing misunderstandings as to American trade methods and ideals. Another important service has been in connection with the amicable settlement of large claims made against Americans by Australian importers. Mr. Ferrin has done excellent trade-promotion work, and substantial business has resulted from his aiding Australians to obtain American agencies.

**Work of Attachés in Latin America.**

The office at Buenos Aires was largely occupied with war work. Commercial Attaché Robert S. Barrett was also the representative of the War Trade Board and the Shipping Board. Mr. Barrett obtained the cooperation of the commercial representatives of the allied Governments and organized a committee, of which he was elected chairman, to take joint action on all enemy-trade matters. He also suggested and assisted in the organization of the Allied Chamber of Commerce of Buenos Aires. To the Shipping Board Mr. Barrett made important and exhaustive reports. During the shipping strike he rendered notable service. Mr. Barrett also devoted considerable time to trade promotion. Largely through his efforts, the United States Chamber of Commerce in Buenos Aires was organized. Many representatives of American firms were assisted, and in one instance an initial order of $100,000 worth of rubber goods was secured. Mr. Barrett made frequent and extensive reports on timely subjects. He resigned April 1 to enter private business, but returned to the United States and spent three months conferring with business men before his resignation was accepted. Dr. Julius Klein, who had served as chief of the bureau's Latin American division, was appointed commercial attaché at Buenos Aires.

J. E. Philippi was appointed commercial attaché at Rio de Janeiro, arriving at his post November 3, 1918. He has devoted considerable time to a unification of the American commercial organizations in Brazil into an effective body, the American Chamber of Commerce for Brazil. The organization, with the aid of Mr. Philippi, has assisted in negotiations concerning arbitration of commercial disputes. The attaché has made a close study of the Brazilian tariff. Following the armistice unusually heavy import shipments were received, and in many lines stocks were largely in excess of immediate needs. The attaché was instrumental in working out plans for handling the situation without loss to the parties interested. Mr. Philippi has kept the Department informed with respect to shipping facilities, freight rates, etc., has submitted many valuable reports on other important subjects, and has aided in various ways American exporters.

During the greater part of the year the office at Lima, Peru, has been in charge of Robert E. Hurd, secretary to the commercial attaché. Mr. Montavon returned to Washington in October to confer with exporters. However, Mr. Montavon decided while in this country to accept an important place with a private organization. His trip through the United States was highly successful. While at Lima the attaché was chairman of the subcommittee of the Allied Conference of Ministers that considered war-trade problems. After the departure of the attaché, Mr. Hurd continued these activities, acting as secretary for the organization.

### Usefulness of Attaché Service Clearly Demonstrated.

The commercial attachés in South America have submitted special reports on the openings for American marine-insurance operations, markets for drawing instruments and architects' supplies, and German competition in all its phases. The attachés at Copenhagen, The Hague, and Paris have studied the status of the German dye industry. Our representatives in Paris and Rome were able to assist the important commissions representing the National Industrial Conference Board and the World Cotton Conference, while the London and Paris offices were of similar assistance to the commissions representing the shoe and leather trades and the Merchants and Manufacturers' Board of the Cleveland Chamber of Commerce. The attaché service created interest in the exhibition held in Philadelphia in June under the auspices of the National Association of Hosiery & Knit Goods Manufacturers.

A striking example of the usefulness of the service is found in its cooperation with the United States Sugar Equalization Board, which asked the bureau whether the attachés could assist in opening up foreign markets for sugar. The attachés were instructed to give the matter publicity as well as take it up directly with foreign importers. Soon the export demand became so heavy that the board found it necessary to restrict the exportation of sugar.

As another example of the utility of the service, I may mention the cooperation of the Bureau with the Bureau of Markets of the State of South Dakota in finding markets for range horses in Europe.

**Vital Work Accomplished by Trade Commissioners.**

The division of foreign investigations has aided the war activities of such organizations as the War Trade Board, the War Industries Board, the Council of National Defense, the Shipping Board, and the War Department. Trade Commissioner Axel H. Oxholm rendered important services in connection with the inspection of timber for the American Expeditionary Force. Trade Commissioner Norman L. Anderson kept closely in touch with matters of interest in the Scandinavian countries, Finland, Germany, and elsewhere. Nels A. Bengtson, trade commissioner at Christiania, cooperated with special representatives of the War Trade Board in Norway.

The lumber investigations conducted by Trade Commissioners Axel H. Oxholm, Roger E. Simmons, Nelson C. Brown, and John R. Walker were practically completed at the end of the fiscal year, and their reports will appear shortly. Upon returning to the United States, each of the investigators made a tour of the principal lumber centers, giving first-hand information concerning the results of his trip abroad. Great benefit will unquestionably be derived from the personal suggestions of the commissioners, as well as from the material in the forthcoming monographs. The regions covered in the investigation were Finland, Sweden, and Norway; Russia and Siberia; the Spanish Peninsula, Italy, and Greece; and Great Britain, France, Belgium, and the Netherlands.

The year witnessed the completion of the field work in the investigation of South American furniture markets by Harold E. Everley and the publication of his book entitled "Furniture Markets of Chile, Peru, Bolivia, and Ecuador." His reports on the east-coast countries will soon appear.

Trade Commissioner W. W. Ewing finished his study of the opportunities in South America for the sale of American construction materials and machinery. A bulletin was published embodying the information that he gathered in Chile, Peru, and Ecuador, and reports on Argentina, Bolivia, Uruguay, and Brazil are being prepared.

Charles C. Hanch conducted a short investigation of the automobile situation in England and on the Continent of Europe.

"Jewelry and Silverware in Cuba" represented the first tangible result of the investigation by Samuel W. Rosenthal into the Latin American markets for the articles indicated. Various other monographs are soon to be published.

Trade Commissioner J. W. Sanger finished his study of advertising methods and conditions in the Latin American countries. His reports are most pertinent and interesting.

Oliver M. Smart has returned to the United States with valuable data on the market for electrical goods in Italy.

During the past year William M. Strachan investigated the production and exportation of certain tropical products in Central America and Colombia, at the request of the United States Shipping Board.

Henry Wigglesworth made a short survey of the general situation in the chemical industries of Europe.

There is now in press a monograph on "Electrical Goods in Argentina, Uruguay, and Brazil," written by Trade Commissioner Philip S. Smith to complete the series resulting from his South American investigations.

The other specialized investigations completed during the year include those of W. G. Marshall on industrial machinery in Italy; H. Lawrence Groves on agricultural machinery in France; Charles P. Wood on industrial machinery in France and Belgium; and Arthur N. Young on financial conditions in Spain.

Trade Commissioner Edward F. Feely made a survey of general commercial and economic conditions in Mexico and has now been appointed commercial attaché at Mexico City.

Louis E. Van Norman was appointed trade commissioner to investigate general trade conditions in Rumania and was stationed at Bucharest for about six months. Having obtained important data on fundamental economic factors, he has returned to this country to give American business men the benefit of his observations.

Leslie C. Wells was assigned to the party of the French Institute in the United States that has been making a tour of France, including the devastated regions.

Among other general investigations should be mentioned those of Nels A. Bengtson in Norway, Harry T. Collings in Belgium, and Eliot G. Mears in Greece. Mr. Mears has been ordered to proceed to Constantinople, to report on general commercial and economic conditions. Mr. Bengtson and Mr. Collings are returning to the United States. General investigations that are continuing as the fiscal year ends are those of P. L. Bell in Colombia and Venezuela, John A. Fowler in the Dutch East Indies and Straits Settlements, Vladimir A. Geringer in Czechoslovakia, and R. A. Lundquist in South Africa. Upon the completion of his work in South Africa (including the preparation of a report on the electrical-goods trade), Mr. Lundquist is expected to proceed to India to study the market for electrical goods in that country.

William L. Schurz was appointed trade commissioner in February to make a general investigation in Bolivia and Paraguay. No trade commissioners have been located in those countries before, though short visits to the principal centers have been made by several commodity investigators of the bureau.

Special investigations now in progress include those of J. Morgan Clements of mineral resources in China; Courtenay De Kalb of mineral resources in Spain; L. S. Garry of textiles in South America; Harry F. Grady of financial conditions in England and on the Continent; Norman L. Hertz of leather in Europe; Alexander Luchars of machine tools in England and on the Continent; W. H. Rastall of industrial machinery in the Far East; Paul P. Whitham of transportation and port facilities in China.

### District and Cooperative Offices.

As with other branches of the bureau's activity, the work of its district and cooperative offices during the past year falls naturally into two divisions—that performed before the signing of the armistice and the work undertaken subsequent to that date.

While the actual handling of export and import licenses was taken out of the hands of the district and cooperative office managers some time before the beginning of the past fiscal year, a great many requests and inquiries continued to reach these offices with respect to the war regulations of this country and of foreign nations. It is estimated that approximately 25 to 35 per cent of the time of the employees of these offices was taken up in furnishing information of this character and in advising business men as to the proper procedure in complying with these war-time regulations while still conducting as much foreign trade as possible.

After the armistice, the urgent demands from American business men for advice and assistance in relation to the new markets taxed severely the limited personnel of the bureau's branch offices. Manufacturers and exporters have, for the most part, expressed deep appreciation of the manner in which their requests were handled.

Probably the most notable feature of the work of these offices after the signing of the armistice was the arrival in this country of a comparatively large number of foreign business men desiring to be placed in touch with American merchants. This is a service for which the district offices are peculiarly fitted, each office manager being in close contact with the business interests of his district and being able, therefore, to place foreign buyers in direct communication with firms which can supply their requirements.

Another feature of the work that has developed greatly during the past year has been the investigation of complaints made against American firms by foreign dealers. In such abnormal conditions as those prevailing during the war it was inevitable that misunderstandings and mistakes should occur. The district and cooperative offices of the bureau have been eminently successful in adjusting these difficulties amicably and without recourse to legal procedure. The effect of this work upon foreign good will toward the United States is evident.

### Work in Connection with Latin America.

June 30, 1919, marked the end of the busiest and probably the most useful year in the history of the bureau's Latin American division, organized in 1916 for the general purpose of promoting American trade with all countries and colonies in the Western Hemisphere to the south of the United States. During its comparatively short existence a large quantity of economic information has been accumulated, the development having been especially rapid subsequent to the entrance of the United States into the war. Like all public and private institutions, the Latin American division has found the fiscal year 1919 composed of two distinct phases—that from July 1, 1918, until the signing of the armistice on November 11, and that after November 11, 1919.

Early in the war the division was called upon to cooperate actively in many aspects of war work involving Latin American affairs. About 50 per cent of the time of the division during the duration of the war was given to the preparation of economic material for war uses and to assistance rendered to investigators from other Government offices. In some instances the war organizations found it necessary to maintain in the division members of their staffs on full-time work. The four offices of the War Department maintaining closest contact with the division were the military intelligence branch, the air-craft procurement division, the gas-defense service, and the Surgeon General's Office.

The division was in particularly close touch with the Shipping Board because of the necessity for careful study of ship service to Latin America with a view to curtailing that service to a minimum in order to supply tonnage for trans-Atlantic troop and munition movements. The files of the division were used as the foundation for data relating to such questions as Mexican petroleum, Latin American merchant marine, fuel supplies of South American countries, interned German shipping in Latin American ports, and Japanese ship movements to South America.

The division was called upon constantly by the War Trade Board for advice on the granting of licenses for exports to Latin America, with special reference to the actual necessity for the given commodity in the consuming countries. As the board undertook to establish its own field service, its various appointees were given special preliminary training in the Latin American division before departing for their posts in the southern countries.

The division furnished to the Food Administration a number of comprehensive tabulations relating to the trade in sisal fiber, sugar, bananas, coffee, and cereals.

Aid was given to the Geological Survey in its investigations of the Latin American supplies and the proprietary control of such minerals as nitrate, petroleum, coal, tin, zinc, manganese, platinum, antimony, and tungsten.

For the Federal Reserve Board members of the division wrote brief treatises covering the effects of the war on exchange in Brazil, Uruguay, Argentina, and Chile.

Data and suggestions were supplied to the Committee on Public Information.

Investigations were conducted regularly for the Foreign Trade Adviser's office of the State Department.

The division also cooperated in collecting economic data for use at the Peace Conference. Numerous reports were prepared for this use.

While the time of the Latin American division was primarily occupied with the war activities above enumerated, prior to the signing of the armistice, the work of supplying trade information to private interests was not neglected. It was often called upon to act as a mediator between private business and the Government war organizations.

The revolution in commercial activity that took place after the cessation of hostilities was reflected in the work of the Latin American division. Manufacturing industries turned to foreign markets as outlets for their production. The average number of letters of trade information written weekly by the division, in response to inquiries received from business houses, increased from 89 in July, 1918, to 220 in April, 1919. The number of visits by export managers, salesmen, and officials of manufacturing firms and export houses grew to 35 or 40 per week.

One of the most encouraging features of the trade-promotive work of the Latin American division has been the regularity with which its services have been used by business institutions recognized as among the most important in the United States. Among them may be mentioned practically all the American banks that have branches or affiliated houses in Latin America, the more prominent steel companies, many of the strongest export and import houses, investment and financial institutions, and many others among the leaders in their respective industries, such as textiles, chemicals, paints and varnishes, jewelry, rubber, motor cars, agricultural implements and machinery, industrial equipment, railway supplies, electrical manufactures, explosives, timber, hardware of all kinds, construction materials, foodstuffs, and, in lesser volume, practically every variety of manufactures.

So far as has been practicable in view of the time necessarily occupied by work of more immediate importance, the division has prepared, on subjects of timely interest, articles involving original research. These reports, to which the name of "Latin American circulars" has been given, were issued during the past year at intervals of approximately two weeks and have been published in Commerce Reports. The series has included reports on the trade balance and foreign exchange of Uruguay and Brazil; railways and railway development in Mexico, Brazil, Peru, and Argentina; petroleum and general trade conditions in Mexico; studies of paint and varnish and automobile markets; and other miscellaneous subjects. A gratifying appreciation of this phase of the division's work has been evidenced not only by personal letters but also by the reprinting of such studies in trade journals and the daily press.

During the last weeks of the year the division prepared a complete syllabus for the use of instructors in Latin American trade courses and of students who desire to pursue such study independently. This work comprises four courses on the main divisions of Latin America, including preliminary references to the history and social heritage of each nation as well as a review of the physical features, transportation, native products, banking and finance, and economic characteristics peculiar to the region under consideration. Commodity studies based mainly on the official reports published by the Bureau of Foreign and Domestic Commerce form the practical end of each course. This syllabus will be embodied in a bulletin to be issued by the Federal Board for Vocational Education about the first of September, 1919.

### Promotion of Trade with Far East.

The Far Eastern division accumulates and distributes trade information in a variety of ways. It clips and files all pertinent articles appearing in about 20 representative Far Eastern trade papers. In order to insure as extensive a circulation as possible for data of this character, a weekly digest of the clippings is made and published in Commerce Reports. These "press notes" are widely copied in trade and news papers throughout the United States. The value of thus directing intelligent inquiry is manifest; it discourages the old type of "dragnet" inquiry that is so difficult to handle and, with more beneficial results, excites the interest of merchants and manufacturers in available material of a specific nature. Lists of selected titles, from the clipping files and the card index of articles in periodicals, are distributed to the bureau's district and cooperative offices.

The duplicate replies of consuls to trade inquiries are filed in the Far Eastern division, and their gist is summarized on cards. Letters of special interest form the nucleus of articles in Commerce Reports, under the heading "Far Eastern trade notes." For Commerce Reports, also, the division prepares summaries of forthcoming monographs by the field investigators of the bureau.

Special lines of investigation for commercial attachés and trade commissioners are suggested by the division, based upon inquiries received from American sources.

The division is assembling a library of great practical value. Yearbooks, directories, studies of economic conditions, official reports of foreign Government departments and bureaus have expanded the bookshelves from 4 to 15 sections.

In the distribution of the information thus accumulated probably two-thirds of the effort has been expended in answering individual inquiries. These have increased from about 25 per week in July, 1918, to more than 125 per week at the termination of the fiscal year. In a surprisingly large number of cases the division has been completely successful in supplying the exact data required.

It was early discovered that there was a steady call for comprehensive surveys of the Far Eastern markets for certain articles entering largely into the export trade of the United States. To meet this demand, 18 circulars discussing the opportunity for such goods in practically all important Far Eastern markets have been prepared and given wide circulation through Commerce Reports and by mailing to a special list comprising virtually all the American manufacturers and exporters actively engaged in trade with the Orient. These circulars have had gratifying results.

The miscellaneous activities of the division during the year have been numerous and exacting. It was called upon for advice concerning the desire of the Chinese Government to purchase railway equipment. It gave attention to the bill introduced in Congress for the incorporation under Federal law of companies engaged in foreign trade exclusively. The subject of better cable facilities across the Pacific was taken up. At the request of the Shipping Board, the division suggested two routes for transpacific steamship service, the accumulation of the necessary data involving much research. The division has been called upon frequently to clear up trade disputes of a peculiarly aggravated nature. A number of addresses before trade bodies have been made by members of the division.

### Establishment of Russian Division.

Among the important undertakings of the bureau during the fiscal year was the organization of a Russian division, under the direction of Dr. William C. Huntington, commercial attaché to Russia. Dr. Huntington was in Russia during the last days of the imperial régime and the entire period from the revolution of March, 1917, to the withdrawal of the American diplomatic representatives.

The Russian division was organized in January, 1919, the staff consisting at first of only the chief and a stenographer. Two additional persons were engaged in March, and since April the work has been very actively carried on. The aim of this work is (1) to make a thorough study of Russia and to build up a collation file of sound, tested information, as well as to form a good library; (2) on this basis to furnish accurate information to business interests; and (3) to form a center for all sorts of American-Russian trade relations.

Numerous articles and translations prepared by the division have been published in Commerce Reports. Russian currency, mineral resources, the flour-milling industry, the beet-sugar industry, the market for textiles and clothing, the port of Archangel, the resources and trade possibilities of Poland, etc., have formed the subjects of such reports.

Many business men, both Russian and American, have visited the division. The cooperative societies and their projects have occupied much time. A large number of inquiries have been answered relative to general conditions in Russia and Siberia, as well as special branches of trade and manufacture. About 300 of these letters have been in the nature of real reports to the inquirers.

The division has endeavored to obtain publications from all sources and has worked in close cooperation with other divisions of this Department and also with the Department of State, the Department of Labor, the Shipping Board, and the War Trade Board. It has worked with the military intelligence division of the War Department.

The division has cooperated effectively with such organizations as the American-Russian Chamber of Commerce, the Russian-American Committee for the Far East, the Russian Embassy, the consulate general of the Republic of Poland, the Russian Economic League, the National City Bank of New York, the National Bank of Commerce, the National Association of American Manufacturers, and various chambers of commerce. Attempts have been made to get in touch with chambers of commerce abroad, in Harbin, Omsk, and Archangel. Arrangements have been made with the State Department to obtain periodically data from representatives in the United States of States organized from portions of the former Russian Empire.

It is confidently believed that this new Russian branch of the bureau's activity will contribute very substantially to an understanding of the Russian problem, aiding Americans to take advantage of an ultimate opportunity for the utilization of capital and the supplying of merchandise to 180,000,000 people.

### Extraordinary Demand for Commercial Information.

The bureau's division of trade information, which supplies, through correspondence and personal interviews, data on foreign markets other than Latin America, the Far East, and Russia, sent out approximately 45,000 communications during the past year. Since the signing of the armistice the facilities of the division have been taxed to meet the truly phenomenal demand for commercial information. Upon the cessation of hostilities American manufacturers whose establishments had grown as a result of war orders began to seek means to keep their plants and organizations intact, and thus avoid the unpleasant task of reducing their forces and curtailing production. The inquiries received by the bureau show that a remarkably large proportion of these concerns have turned to foreign trade as a solution of their problems.

In connection with its trade-promotion work the bureau maintains close cooperative arrangements with the principal commercial organizations throughout the United States. An important supplemental publicity is thus given to the bureau's publications and special services. In turn, the division of trade information is often able to be of definite assistance to such associations and their individual members. It is called upon frequently by newly established associations, planning the organization of foreign-trade departments, for advice and constructive suggestions that will assist them in initiating, developing, and carrying on a special service of this kind.

### Division of Statistics.

During the first half of the year the efforts of the division of statistics, aside from the regular work of preparing the statistical publications, were directed mainly toward furnishing the special war bureaus with the detailed foreign-trade statistics required by them.

The various divisions of the United States Shipping Board made probably more extensive use of the statistics than any of the other war offices. As a basis for the control and allocation of ships for imports of essential war materials for which the United States was dependent upon foreign sources, the division of planning and statistics of the Shipping Board was supplied regularly with reports of imports during 10-day periods. The port and harbor facilities commission of the Shipping Board made extensive use of the monthly reports showing imports and exports of each customs district by articles and countries. The division of operation made extensive use of the bureau's reports of "Vessels entered and cleared in the foreign trade," while the division of trade was given aid in the construction of tables showing commerce in leading staple articles by ports and countries.

The Food Administration and the Bureau of Markets of the Department of Agriculture were furnished with 10-day reports of imports and exports of foodstuffs and agricultural raw products.

The several divisions of the War Industries Board and the Council of National Defense made constant inquiries for foreign-trade statistics in connection with their work of priority rulings, price fixing, and other war restrictions, and received numerous special monthly and 10-day statements.

The Geological Survey, the Bureau of Mines, and the interdepartmental War Minerals Committee were kept regularly supplied with the latest statistics on imports and exports of nonferrous metals, coal, mineral oil, nitrogenous materials, and other essential minerals.

The War Trade Board made constant use of the import and export statistics, its bureau of research being regularly furnished with copies of the 10-day and monthly export reports, and every facility was afforded its officials to keep their statistical records up to date. Numerous special tables were also furnished to that board.

Among the other Government establishments to which information was supplied by this division were the Central Bureau of Planning and Statistics, the Committee on Public Information, the Alien Property Custodian, and the Director General of Railroads. In many cases extensive research and compilation were required.

Since the signing of the armistice this extensive use of the bureau's foreign-trade statistics has gradually diminished, so far as the war boards are concerned, while there has been a corresponding increase in the demands by private industries and commercial organizations. It is the policy of the division to furnish as complete statistics as possible bearing upon the inquiries submitted.

For several years the division has maintained a limited service of special monthly statements to certain parties, giving more details than the published reports. It was decided to extend this service by furnishing it to such trade journals and commercial organizations as would agree to give publicity to the statements. The demand has exceeded all expectations. The work was started with statistics for December, 1918. After it had been in operation for six months, 1,178 copies of 81 statements of imports and exports during May, 1919, were furnished to about 300 different addresses, mostly those of trade organizations and commercial journals.

Special arrangements have been made with local correspondents of trade publications by which they are given access to the copy for the Monthly Summary before it is sent to print. Thus the figures of imports and exports in the principal lines of industry—including, among others, automobiles, textiles, iron and steel, and hides and leather—appear in the trade journals a week or more in advance of the official statistical publications.

The Department of Commerce is aware of the importance of promptness in the statistical service and is giving much attention to the coordination of the bureau's work with that of the Customs Service of the Treasury Department, through which the reports are collected. In recent months there has been a notable improvement in this regard.

An act of Congress approved January 25, 1919 (S. bill 4924), amended section 336 of the Revised Statutes by requiring that the annual report shall be issued to cover the calendar instead of the fiscal year, because of the greater demand for figures relating to the former period. For 1918 the bureau undertook to prepare, in addition to the fiscal-year report, an annual report on the Foreign Commerce and Navigation of the United States for the calendar year. In order to provide a continuous record for the intervening period between the fiscal and calendar years, the figures for the half year from July 1 to December 31, 1918, are shown in all of the tables in addition to the calendar-year figures.

Steps are being taken to change the tables in the foreign-commerce section of the Statistical Abstract from fiscal to calendar years.

The usual publication Trade of the United States with the World, showing imports and exports in the trade with each foreign country by articles, was brought up to date for 1918 and issued as Miscellaneous Series No. 78. A special compilation was made and published in Commerce Reports of the imports into and domestic exports from the United States during the calendar year 1917, stated in the terminology of the international classification agreed upon at the International Statistical Congress at Brussels in 1913.

To remedy the lack of detail in the foreign-trade statistics, a revision and extension of the export classification was undertaken in the latter part of the fiscal year. An interdepartmental committee was appointed, comprising representatives of the Treasury, Agriculture, and Commerce Departments, the Shipping and War Trade Boards, and the Tariff Commission, for the purpose of preparing an entirely new classification applicable to both imports and exports. It was decided that the present alphabetical arrangement should be discarded and that the commodities in the new classification should be grouped in 10 great classes according to their character, the origin of the component materials rather than their use being the guiding principle in classifying. Each of the 10 main groups is to be divided and subdivided into subsidiary groupings, the decimal system of numbering being used in order to facilitate mechanical tabulation and to provide elasticity for future expansion. Comparability between imports and exports is to be preserved, but in cases where the imports or exports are not of the same importance for certain groups the classification need not be shown in the same detail. Quantities are to be shown in all cases either in standard commercial units or in weights.

Trade organizations and experts have prepared detailed schedules for their particular lines. The arrangement and condensation of the various classifications submitted has proved a huge task. It had been planned to put the new classification into effect on January 1, 1919, but this was found impracticable, and the work has continued uninterruptedly up to the present time. It is expected that January 1, 1920, will be the effective date, unless some now unforeseen event should make further postponement necessary.

### Original Research and Compilation of Foreign Statistics.

In the research division of the bureau there were prepared during the year, in addition to the Statistical Abstract of the United States and the annual pamphlet on wholesale prices, special publications on Statistics of German Trade, Statistics of Austro-Hungarian Trade, International Trade in Footwear, and International Trade in Cement. The two reports on the commerce of the central Empires have proved of great value to students of their economic development, as well as to business men who are interested in the markets formerly supplied from Teutonic sources. Studies are in course of preparation covering the international trade in cotton goods, motor vehicles and bicycles, horse-drawn vehicles, agricultural implements and machinery, paper and its manufactures, electrical goods and machinery, and manufactures of leather other than boots and shoes.

The research division prepared the statistical tables for the bureau's monograph on Economic Reconstruction in European Countries.

In order to assist in placing American oversea trade on the firmest possible basis, one of the experts of the research division, during the last half of the fiscal year, has paid special attention to the possibilities of employing American capital abroad. In the Far East and Latin America are great resources that have scarcely been touched, and it is believed that this branch of the bureau's activity will conduce very materially to the profit of American financiers and merchants.

**Division of Foreign Tariffs.**

During the past year the publication work of the bureau's division of foreign tariffs had to be largely subordinated to the rapidly growing correspondence, dealing primarily with the great number of foreign restrictions on commerce. The increase in the division's mail was particularly noticeable after the armistice, reaching a monthly average of nearly 1,000 letters, compared with an average of less than 250 during the preceding year. Inquiries regarding foreign rates of duty were comparatively few. The foreign import restrictions, on the other hand, formed a very serious obstacle to export trade, and it required a considerable amount of ingenuity and diplomacy to get the average exporter to see the broader problems of exchange, international commercial policies, and national interests involved in the import prohibition on the particular article in which he was interested.

The work of the division in connection with foreign trade-mark legislation, and especially the examination of official publications with a view to detecting attempts to pirate American trademarks, has been considerably extended and has resulted in a number of very desirable new connections among American firms. The division has also succeeded in aiding American firms to recover trade-marks that had been appropriated by their agents.

The question of the expansion of American parcel-post facilities with foreign countries has figured rather prominently in the work of the division, which has kept in close touch with the activities of the Post Office Department along those lines. It is gratifying to note that the economic importance of parcel post is receiving increased recognition and that parcel-post service to a considerable number of countries has been inaugurated during the past year.

**Editorial Division.**

Up to the time hostilities ceased there was so pronounced a shortage in incoming reports from the bureau's field staff that for a time the editorial division seemed confronted with the inevitable necessity of reducing the size of Commerce Reports. But within a month after the armistice was signed there were so many reports in hand that the facilities of the division and of the entire bureau were taxed to give them proper distribution.

The work performed in the division during the year amounted to approximately 12,800 printed pages, as compared with 10,872 pages during the preceding year. Fourteen monographs were prepared for publication in the Special Agents Series and 12 in the Miscellaneous Series. The number of pages in Commerce Reports jumped from 4,912 in 1918 to 5,760 in 1919, the increase occurring during the last six months. The number of foreign-trade opportunities published in this daily paper increased from 806 for the first six months of the fiscal year 1919 to 1,897 for the six months just closing. An increase of more than a thousand in the paid circulation of the paper has also taken place.

A new series of publications, designated Industrial Standards which will give substantial aid in trade promotion with Latin America, made excellent progress during the year. The first 62 numbers in the series have been issued. They are bilingual editions, in Spanish and English, of standard specifications of the American Society for Testing Materials. This work will be continued during the current year by the translation of these specifications into French and the publication of French-English editions for distribution in the several countries of Europe where that language is used. It is also planned to publish a bilingual edition, in French and English, of the Standardization Rules of the American Institute of Electrical Engineers.

**Recommendations.**

1. The commercial-attaché service has, during the four years that it has been established, amply proved its value. There has been a distinct field to be filled by men with broad economic and business training devoting their entire time to the important problem of promoting American commerce abroad. Commercial attachés have in almost every instance been of continued assistance to the embassies and legations to which they have been attached, because important commercial questions have been constantly coming up where the advice and assistance of a trained man were of great value. It can further be said that commercial attachés have constantly been of assistance to other departments of our Government which have sent important official representatives abroad. Commercial attachés have turned their hands to whatever task of a commercial character was at hand to do.

At the same time constant assistance has been given to visiting American business men who have been endeavoring to enter new markets and to organize their business along sound lines. The commercial attaché has been a commercial counselor of high grade whose service has been found so useful that his time and energy have been taxed to the utmost. It is in accordance with proved usefulness that I strongly recommend the extension and improvement of this service. The kind of men who are useful for this work can obtain large salaries in the employ of American companies engaged in export business, as evidenced by the fact that commercial attachés have been lost again and again on this account. After an official of this class has the advantage of several years' experience it is a distinct loss to the Government to have him leave and to have to put in a new man. The responsible nature of the commercial attaché's work and the high-grade men required make it necessary to pay higher salaries than we have been able to do. It is also necessary to provide more clerical assistance than has been permitted under the organic law. I recommend substantial increase in the appropriation for the commercial-attaché service.

2. Under the general head of "Promoting commerce" come the special investigations made by trade commissioners, the functions of the district offices, and other work of similar character. It has been possible to obtain high-grade specialists to make investigations in specific lines. Reports and monographs which have been published at regular intervals have been utilized to a great extent by the different trades. This is a work which I feel should be continued. The district offices, established in principal cities, have come to be focal points for foreign-trade information and have done splendid work in making available a large amount of commercial information received from American representatives abroad These offices are in need of larger staffs and higher salaries. Again and again district office managers who have done excellent work have been given positions with private firms at higher salaries.

3. The Latin American, Far Eastern, and Russian divisions have coordinated commercial information relating to their respective territories and have made it available to American exporters. This specialized service has met with an excellent response. It is a kind of work which I believe should be extended.

4. It is important that the Bureau of Foreign and Domestic Commerce should have an adequate sum for post allowances to be

granted to its representatives abroad to offset unusual high cost of living charges and uncertain conditions prevailing at the present time in different countries. The wisdom of granting post allowances has been demonstrated in the case of the American diplomatic and consular service under the Department of State.

5. The Bureau of Foreign and Domestic Commerce distributes to the American business public not only information received from its own representatives abroad but also a large amount of valuable commercial intelligence which comes in from American diplomatic and consular officers. During the present period of international trade adjustment it is important to have frequent reports to indicate changes which are constantly occurring. This current commercial information should be transmitted to interested American exporters without delay. The statutory staff of the Bureau of Foreign and Domestic Commerce is the medium through which this information must pass. With an unprecedented amount of valuable information to distribute and a greatly increased demand on the part of the public for information of this character, the strain placed upon the statutory staff of the bureau has been very great. It is necessary to have an increased clerical force and also added provision for competent administrative officers. The salaries in the bureau in Washington have not been sufficient to hold highly trained men, who have left the service to enter private employment.

6. The international trade situation is to-day a matter of vital importance to the prosperity of this country. It is essential that the most authentic information about foreign markets be obtained and distributed. In order to do this work effectively, sound constructive plans should be made. Men trained in foreign investigation and in the analysis of foreign-trade conditions are to-day in very great demand in private business. The Bureau of Foreign and Domestic Commerce has been to a considerable extent a training school for men who have later obtained important positions with private companies. It is my opinion that the time has come when sufficient means should be provided so that the foreign-trade service of our Government, represented by the Bureau of Foreign and Domestic Commerce, may be placed on some permanent self-supporting basis, so that accumulated experience may be retained. The service of the Bureau of Foreign and Domestic Commerce deserves to be given increased appropriations necessary to enable it to carry on successfully the valuable work which it is attempting to do.

# NATIONAL BUREAU OF STANDARDS.

(Dr. S. W. Stratton, *Director*.)

The National Bureau of Standards is organized in nine scientific and technical divisions, the office, the mechanical plant, and the technical shops—88 separate sections in all. The bureau's staff during the year included 1,150 employees. The scientific library has 17742, volumes, chiefly in physics, chemistry, and the special technologies, and 442 scientific periodicals from all parts of the world are currently received. There are 13 principal laboratory buildings, connected by service tunnels, and the equipment includes a liquid-air plant, a refrigeration system, power plant, gas and electric generators, and a system of technical services, such as time signals, electric current, gas, steam, compressed air, vacuum refrigerating brine, and others which are connected to the various laboratories. The bureau also has woodworking shops, instrument shops, a glass-blowing and a glassworking shop, and a well-equipped photographic laboratory.

The transition from war to peace brought special problems of reconstruction of work in the face of reduced funds, and many resignations, aggregating 378 (exclusive of 1,127 separations of a temporary character). To maintain the staff, 1,909 appointments were made. Certain military researches were continued because of their permanent value to the Army and Navy. Researches for other departments and for the industries—deferred somewhat during the war—were resumed, and peace programs of industrial research were taken up vigorously. Estimates were submitted to Congress for this industrial work.

The scientific and technical knowledge derived from researches and investigations is disseminated through printed publications, 51 of which were issued during the year, comprising 36 new issues (12 scientific papers, 15 technologic papers, 6 circulars, and 3 miscellaneous publications) and 15 revised editions. A descriptive list of publications was issued, in which there is given a brief technical abstract with each title, which, with a subject index, makes it specially useful to experts interested in any of the bureau's varied fields of work. In addition, the bureau issues a series of monthly technical news bulletins, in which during the past year 426 separate topics were treated, thus giving promptly summary news notes of the bureau's researches. An important function of the bureau is to make quickly accessible the results of new scientific researches.

**Weights and Measures.**

During the year, in its new circular on the measurement of mass, the bureau announced new standards of construction and accuracy for weights. This type of service in the interest of national uniformity is of great value to science and industry. The bureau also certified weights, giving corrections for each, so that fairly accurate weights may give very accurate results when the certified corrections are applied.

In the bureau's weighing laboratory 2,594 weights and 36 balances were standardized. Many interesting problems were handled, new methods of determining the weight of a bushel of wheat from samples, verification of standard grain testers, errors in weights caused by brittle lacquer, and the discovery that atmospheric humidity seriously affected the behavior of the bureau's new precision balance for assay weights.

In a larger way the bureau standardized mine scales and railroad track scales, using its traveling test cars, each equipped with weights totaling 100,000 pounds. During the year bureau experts inspected mine scales in Ohio, West Virginia, Kentucky, and Maryland, where bad conditions were investigated and rectified. The necessity of regular testing was clearly proven, the State mining laws were clarified on the points involved, effective safeguards assured, and the suspicions and discontent of the miners allayed. In all 352 railroad track scales were tested by the bureau in 33 States of the Union on behalf of the U. S. Railroad Administration, including 10 master scales used as standards to check locally the weights of the railroad's track-scale test cars. The results of the bureau's work are being incorporated in standard specifications for railroad track scales, prepared in cooperation with the technical interests concerned. These will promote efficiency and accuracy in large scale weighings on railroads, the importance of which may be gauged by the freight revenues collected on the readings of railroad track scales amounting to several billion dollars in a year.

The Twelfth Annual Conference on Weights and Measures at the Bureau of Standards, attended by 180 experts and delegates representing 29 States, adopted specifications for gasoline-measuring pumps, recommended that the bureau be empowered to pass upon types of measuring devices, approved the decimal flour bill, favored the sale of dry commodities by weight, the marking of net weight on wrapped meats, standardization of packages, and advocated the adoption of the international metric system of weights and measures.

The bureau has formulated model State laws, held conferences on the technical details of inspection service, and consulted State and local officials on technical legislation. Much of the new legislation is developed with the cooperation of the bureau. Several States, notably Texas, North Dakota, and South Dakota, have just enacted laws establishing State-wide inspection services for the first time. Many States ask aid in establishing State departments of weights and measures, in field investigation, and in deciding the fitness of measuring devices. Specific aid was given Maine and Texas where new laws provide that after July 1, 1920, no weighing or measuring apparatus may be sold unless it is approved by the Bureau of Standards. These actions emphasize the need of a similar national law.

The bureau's length laboratory is the agency for the basic control of all length measurements and all measures derived therefrom. The distribution of accuracy in length is mainly through the standardization of the manufacturers' standards, which control output, and through the standardization of the State standard by which local inspection is regulated.

The bureau also devised means to measure the thickness of paint films—a problem of protection of ordnance shells, the paint film on which must be thick enough to protect and thin enough to avoid rubbing when fired. Methods were also developed to measure, with a high degree of accuracy, the celluloid photorecords of gunfiring. The wide range of technical uses of sieves in industrial laboratories and the great importance of fineness determinations led the bureau to a scientific study of the whole subject which has resulted in a revised scale of sieve sizes.

No length measures are more interesting than the modern precision gauge blocks by which the dimensional accuracy of tools, machines, and countless other factory products is assured. The bureau's successful development and production of gauges, which excel by 100 per cent the quality and accuracy of the best imported gauges, is now well known. The high precision of these gauges is controlled by the direct use of waves of light to measure the errors, some of them less than one-millionth of an inch. The Government was unable to obtain the needed gauges of this type from foreign makers during the war. It is interesting and significant that the bureau was able to develop the methods and make up enough gauges to supply the Government need at a total cost less than the market value of the imported gauges needed at the outset.

The bureau conducted courses of instruction in measurement and in the use of the bureau's special gauge-testing apparatus and methods in field work. The courses were attended by Government supervisors and inspectors from both War and Navy Departments and from manufacturers of munitions and military material.

Valuable work of the highest precision attainable is being done on the measurement of the expansion of materials with temperature. Two examples of the 121 tests made will illustrate. The bureau developed a new type of porcelain for use in spark plugs of motors. To prevent cracking at the high heats encountered, the expansion of spark-plug porcelain in service should be exactly the same as that of the metal electrodes used in producing the spark. So, too, dental filling amalgams must be "balanced"; that is, made up to expand equally with the teeth. The measurement of the minute changes of size involved required optical methods, the expansion being measured by the use of light waves. As a result of this work, specifications will be drawn up for these materials by the bureau in cooperation with the research institute of the National Dental Association.

The need for the bureau's work in standardizing capacity measures for technical uses is shown by the fact that only two-thirds of the volumetric apparatus tested by the bureau during the year passed the test. These measures included burettes, cylindrical graduates, dilution pipettes, transfer and measuring pipettes, and flasks. One-sixth of the density-measuring devices, hydrometers, salinometers, etc., were rejected. In addition to the testing of gas-meter provers, the bureau made an inspection of 103 large natural-gas meters used in supplying towns with natural gas, and disclosed the fact that several million dollars' worth of gas is being ✓ lost in a year by leakage in the distributing systems.

The Government shipbuilding program involves, among other things, a continuance of the testing of special timepieces for the new ships. In the time laboratory nearly 10,000 timepieces were tested, ranging from 12 minutes for stop watches to 100 days for master-clock systems. Class A certificates were given for 19 out of 82 watches tested. The system for testing is thoroughly established and the fundamental time indications of the Riefler standard clock of the bureau is maintained with a constancy within a small fraction of a second a month.

**Electricity.**

Electrical science and industry depend upon the bureau's fundamental standards for uniformity in the electrical measures and data which are the basis of all electrical work. These standards are applied to the industries largely through the makers of electrical measuring instruments and appliances. The manufacturers' standards are checked up at the bureau, thus assuring nation-wide uniformity at the source.

The bureau's electrical testing for the industries keeps it in close touch with industrial needs, and its testing for the Government assures suitable quality of delivered supplies and yields data needed by the bureau for perfecting standards of quality and performance. Such standards gather up new scientific results and service experience and apply them in the industries through the specifications for supplies and equipment, and thus become an agency for stimulating industrial progress.

The electrical laboratories cover work in photometry, radio communication, X ray and radium, and public utilities.

The bureau's researches in the war involving electrical principles covered many subjects—the location of enemy batteries by means of sound-recording mechanisms, the electrical control of airplane guns to fire between the propeller blades, time studies of gunfiring, variation of gun pressures, ejection-velocity studies by recoil meters, the development of kinemometers to measure the jumps and whip of a gun on firing, the measurement of projectile velocities inside the gun, and scientific studies of the gun blast. A special investigation of battleship-turret firing was made and the firing circuits greatly improved. From experimental work and the theoretical studies involved the bureau was enabled to develop numerous new devices and methods of measurement applied to artillery problems The bureau's technical resources and ingenuity were applied to perfecting the plans of experiment and the devices themselves. The results in actual practice have been gratifying. A bureau expert was sent to France and England to further study the problems of gunfiring, and the basis for new and important work has been thus established. Other electrical military work included the investigation of technical methods of protecting ships against mines, the measurement of speed of bullets fired by centrifugal guns, and a large amount of technical consultation work on electricity applied to warfare. A recent report of the War Department announced that the latest sound-ranging system developed at the Bureau of Standards for the location of enemy batteries proved to be superior to all such systems in use when the armistice was signed.

An electrical method was also developed for measuring the velocity of flame propagation in the cylinders of internal-combustion engines. This is a contribution to the general problem of automotive power plants, the full program for which is being vigorously taken up by the power-plant laboratory of the bureau. The electrical principles involved in the design of spark plugs, magnetos, and complete ignition systems are carefully studied. It is of interest to note that in connection with the investigation of the design of this new spark plug, the bureau's ceramics staff developed a new type of porcelain, having the electrical and thermal properties required.

The war made necessary the standardization of military supplies. The bureau's cooperation was sought, and some of its experts gave their full time for several months with a highly gratifying result. In fact, the success opened up the subject of standardization on a much broader scale, and, especially in connection with the electrical supplies and equipment, a most thorough standardization was completed. The results are embodied in the new catalogues of military supplies.

A valuable standardization work was the development of standards of quality and performance for electric dry cells. The vast number of these cells used throughout the country and by the Army and Navy made the subject one of considerable economic importance. The investigation was successfully completed and the results embodied in a published circular giving the specifications for and methods of testing dry cells. A similar work on storage batteries is well under way.

The bureau developed a method by which aviators may land in the fog or dark. The system involves the use of automatic radio signaling equipment on the landing field in combination with suitably designed direction finders on the airplane. Practical trials proved entirely successful. The development was undertaken for the Air Mail Service. A landing field was equipped for the purpose. Automatic signals are encountered by the airplane as high as 6,000 feet from the ground, and with the direction finder the aviator locates his position with respect to the ground and descends safely in fog or darkness. The bureau also developed and successfully applied the most successful submarine radio system, making possible signaling from a submerged submarine for a distance of 12 miles and the receiving of signals transmitted thousands of miles exactly as when received in the air. This work involved the development of a satisfactory direction finder for use under water.

The bureau has rendered special service to radio communication in connection with the so-called "electron tube," sometimes called by the more general name "vacuum tube." The new electron tubes have revolutionized methods of radio communication since the outbreak of the war. The development has been so rapid that it became necessary to completely standardize electron tubes, so that their performance could be predicted in every essential respect. This theory was worked out, and the methods developed are described in a bureau publication now in press. Radio-research headquarters for the Army and Navy radio service are located in the laboratories of the Bureau of Standards, and there has been most cordial and complete cooperation between the Bureau of Standards, the Navy, and the War Department experts.

**Public Utilities.**

The standards for public utilities developed by the bureau relate especially to electric light and power, gas, street-railway, telephone service, and miscellaneous industrial utilities. The bureau conducts scientific and engineering research, studies the public-relations question, prepares specifications for the quality of such service, outlines methods of testing and inspection, formulates safety rules to safeguard the employees and the public, and collates and distributes information impartially to all concerned. Public-utility standards are based upon standards of measure, quality, and performance, and embody in numerical terms the ranges of the pertinent factors defining quality, safety, economy, convenience, and efficiency. Owing to the unusual conditions, the public-utility staff of the bureau during the past two years has been called upon for an unprecedented amount of work. The bureau attained an enviable position as an impartial referee in such subjects and settled disputed questions on a scientific basis. The work has been especially fruitful in assuring to the public a means of specifying adequacy and safety in the production and distribution of electric power, gas, and other forms of service.

The bureau's gas-service standards have proved of great usefulness. Cooperative investigations have been made on behalf of State and local public-service commissions in several States and for many cities. On behalf of the State commission for Indiana cooperative tests at coal-gas plants in the State resulted in new features of gas standards fully set forth in the bureau's report—the most complete and convincing effort ever made on behalf of a public-service commission to determine the best requirements for a State. The data will be valuable to the gas industry.

The bureau's investigation of an industrial-gas enterprise in Maryland resulted in technical recommendations to the management which will "ultimately turn a loss into a substantial profit." The bureau's staff visited 14 different localities, in addition to supplying many requests for information by correspondence and in conference. Much valuable data were made available for the gas companies and the municipalities on matters of controversy or public agitation.

The bureau's standards for electrical safety service are being revised on the basis of experience. In this work the bureau has had the cordial cooperation of public-service commissions, municipalities, and public-service corporations, as well as of national technical societies and individual experts interested in the production and use of electricity.

A new publication is now in preparation which will give the bureau's new "Standards for street lighting service." The experimental and field investigations of street lighting upon which these standards are based, comprised inspections of municipal and private plants, the direct measurements of street lights, and conferences with illuminating engineers and plant managers. Somewhat new in kind is the bureau's study of standards for central station, hot-water heating service undertaken for the State of Indiana. Technical rules covering the factors of adequacy and safety of such service formulated by the bureau were adopted substantially as recommended. These standards are included in a circular on "Standards for steam and hot-water service" now nearly completed.

Telephone service standards are of nation-wide importance, and the bureau is preparing two publications on the subject. The bureau gathers technical data for impartial dissemination to the telephone industry, to regulatory commissions, and to the telephone-using public. One new circular will give an account of the modern telephone service, and a second will describe in detail the service in selected cities. The bureau assisted in standardizing and defining the technical terms employed in telephony in America and Great Britain.

Standards of safety have engaged the earnest attention of the bureau's staff with a view to reducing life and property hazards arising from the use of electricity and from general industrial processes.

The Electrical Safety Code, of which a new edition is now in preparation, has been adopted by at least 20 administrative bodies throughout the country and recommended for use by many others. In several States, notably Pennsylvania, Wisconsin, and Montana, this code is now mandatory. It has been voluntarily adopted by a large number of industrial concerns and, in general, has met with nation-wide approval.

There was held at the Bureau of Standards a conference on industrial safety codes which was attended by more than 100 representatives of different interested organizations. The conference agreed that the Bureau of Standards should lead in the work, and plans are now under way to arrange the most effective cooperation in the preparation of industrial safety codes. The bureau has already prepared a number of such codes, namely, National Elevator Safety Code, National Code for Safeguarding Machines and Machine Drives, National Code for the Protection of Head and Eyes of Industrial Workers, and National Code for Safeguarding Remote Control Apparatus.

The bureau's technical investigation of the damage to structures by stray electric currents from street mains has resulted in the development of standard electrolysis surveys and standard procedure for electrolysis mitigation. Solutions were recently arrived at in several cities in Missouri, Ohio, and Indiana. New apparatus for use in electrolysis surveys has been designed, constructed, and tested at the bureau. The results are so satisfactory that they will be applied to the bureau's field work during the next few months.

**Radium.**

The importance of radium in surgery and in dermatology has caused a rapid growth in the bureau's testing-of-radium preparations, 474 of which were tested during the year, containing a total of 13,159 milligrams, having a market value of $1,500,000. These specimens were certified about equally for the military departments, for commercial export, and for domestic use.

An important use of radium salts is in the self-luminous paints for marking watch dials and other objects.

The modern use of such materials containing radium salts has rapidly developed. The demand for their standardization resulted in the bureau's taking up the work at the request of the Army and Navy. The bureau furnished information concerning the properties of luminous materials, methods of measuring their brightness, estimates of cost of preparation of apparatus and supplies for factory inspection of the dials, extended study of selected specimens by experiment, and the preparation of models. In this work the bureau has had the most cordial cooperation of the manufacturers and civilian users. Much information is included in a circular on "Self-luminous materials," prepared by the bureau for early publication.

**Heat.**

The measured control of temperature is a vital factor in many industries. The Bureau of Standards maintains the standard temperature scale for the country, conducts researches in heat and temperature measurements, the measuring apparatus used, and distributes samples of standard pure metals having certified melting points, and of standard materials having certified combustion heat values. These certified materials are used locally to standardize the heat and temperature measuring apparatus in industrial laboratories for the control of processes of production. During the past year 20,000 thermometers and other heat-measuring devices were tested and certified in the bureau's laboratories. The heat division also serves as a national bureau of information on temperature and heat measurements; hundreds of letters and scores of visiting experts have called for a wide range of data needed in the conduct of industrial researches or in the control of industrial processes.

The maintenance of the fundamental temperature scale requires elaborate researches and exacting experimental work. The scales are fixed by the melting and boiling points of metals and other materials, the basic 100° interval lying between the freezing and boiling points of water. A type of research required is illustrated in a paper, published during the year, on the standardization of the sulphur boiling point, one of the fixed points of the temperature scale. To secure constancy of indication of this boiling point, specific experimental conditions must be carefully observed. Similar precautions must be adopted in all other fixed-point determinations. A new thermometer comparator was devised in which melted metal secures the needed temperature uniformity.

Success in producing high-quality optical glass depends upon the removal of internal strains by effective annealing methods. The heat experts of the bureau recently developed methods for such annealing and for determining by simple tests the practical temperatures required and procedure to be followed. The time-temperature curves for producing·ovens were worked out by bureau heat experts for two leading types of coke ovens. The determination of the properties of ammonia now completed supplies refrigeration engineers for the first time with complete and reliable data on this important material, for the calculation of tables covering ranges from −75° to +70° in place of the meager data previously available.

During the year 106 structural columns were tested in the systematic program of investigations on the fire-resistive properties of structural materials to furnish needed basic data as to materials commonly used in buildings under fire conditions. Fire tests were followed by water application to determine the final resistance of the columns to fire and their action when suddenly cooled by hose streams. The resulting data are the most comprehensive ever available. Unprotected steel was found to sustain loads for less than a half hour, concrete columns for over eight hours. Duplicate tests checked within 10 or 20 per cent. The bureau also cooperated in fire-safety work and in the movement for fire protection and prevention. Special conferences were held on the hazards in cotton ginning, fertilizer handling, petroleum shipping, pyroxylin plastics, including motion-picture films.

The Bureau of Standards has the only "altitude laboratory" in the country. This is a small room which may be made airtight and the air partially removed to produce the low pressures encountered at high altitudes. The laboratory and results obtained have been described in four published reports. The engine to be tested is operated in the room and is supplied with cold air at temperatures actually encountered at any altitude desired. Aviation engines of several types, including the "Liberty 12," have thus been tested at simulated altitudes of 30,000 feet under the most scientific observation and measurement.

The new "altitude laboratory," now nearly completed, will furnish ampler space and exceptional facilities for testing internal-combustion engines for automotive purposes. Scientific studies on basic problems are in progress; for example, on the rate of flame propagation in a gas-engine cylinder and on pressure cycles, carburetion, ignition, lubrication, etc. The work is a splendid example of technology developed during the war and adapted almost without change to important industrial uses.

A series of informal bulletins were issued to disseminate the results of the bureau's engine researches. Seven such bulletins treated of spark-plug problems, seven of engine radiators, and other reports will appear in the next volume of the proceedings of the National Advisory Committee for Aeronautics. The demand for the bureau's tables of melting points of the chemical elements exhausted the edition, and a more complete edition, recently prepared, completes the present data on fixed temperatures. The bureau has published a number of scientific papers on high temperature subjects; e. g., optical methods of temperature measurements above 1,500° centigrade; recording pyrometry for use where a printed record is useful; automatic control of high temperatures by which, for example, the supply of fuel is automatically varied to maintain the furnace at any desired temperature. Serious losses entailed by furnace failures make a recent paper on the melting points of refractory materials a timely contribution to industrial economy.

### History of the Production of Optical Glass by the Bureau of Standards.

The removal, now in progress, of the optical-glass plant from Pittsburgh to Washington closes the first period of its history. A brief résumé of its work follows:

For some time prior to 1914, the bureau had felt the necessity of the United States shaking off the yoke of complete dependence on Europe for its optical glass. European manufacturers had so carefully guarded the secrets of their technique that the necessary preliminary investigations were far too extensive and too expensive to expect commercial corporations to undertake the pioneer work. With this object in view, a scientific expert, with a knowledge of glass making, was appointed in July, 1914, to take up experimental investigation of the production of optical glass. He was not an expert in optical glass, however, for there were none in this country at that time. The necessary preliminaries had been completed by December, 1914, is shown by a report of three "runs of optical glass" for that month.

In 1915, 76 melts and 54 pots were made, a new furnace built, 3 different types of optical glass produced, and some annealing experiments carried out.

The new developments of 1916 included the building of a three-chamber furnace, comparative corrosion tests of the molten glass on pots made of domestic and imported clays, the production of a "very satisfactory" new mixture for pots, and, finally, a batch of borosilicate glass, free from striæ, although not entirely free from bubbles.

The investigations of 1917 brought out the fact that the poor melts were largely due to unsatisfactory pots. So, the solution of this problem was attacked with increased vigor, resulting in one of the most important steps forward in the history of glass production anywhere; i. e., the casting of pots instead of making them by hand. This method greatly reduces the difficulty, the time, and the cost of making the pots. Those obtained on the market were strongly attacked, especially by the barium glasses, sometimes being eaten entirely through by the molten glass, with the result, of course, that the glass mixture was both impure and discolored.

When this country entered the war in April, 1917, the bureau had made over *one hundred* melts of glass and nearly that many pots.

Furthermore, it was *at that time* making melts of the important borosilicate and barium crown glasses on a commercial scale. In November, 1917, 16 melts of 600 pounds each were reported and shipments to the factories made. From then on regular shipments continued, that one in the month preceding the armistice being recorded as 3,021 pounds of first-grade binocular glass, representing more than 15,000 pounds of glass actually produced.

True to the original object in view, the bureau, in addition to the production of considerable optical glass for military purposes, has at all times given freely all possible assistance to those engaged in the manufacture of glass. They have frequently consulted its experts as to methods of manipulation, materials, and the manufacture of pots. Conferences have been held at the bureau and its experts sent to the factories when requested. These efforts have been cordially received and appreciated, as shown at one of the meetings of the optical-glass section of the War Industries Board, where the president of a large glass corporation stipulated that they would take up the production of optical glass for one of the entente nations provided the Bureau of Standards would send experts to the factory to lend technical help.

### Light.

The bureau develops light standards, instruments, and methods for measuring light illumination, and determines the optical properties of materials and optical instruments. The precise measurement of light waves, apparently of purely scientific interest, proved to be of the utmost practical value during the war, since light waves were used by the bureau to control the accuracy of the master gauges used in the manufacture of munitions.

The bureau continued the precise measuring of standard wave lengths of selected radiation of the various chemical elements. Special experience and facilities in red and infra-red photography enabled it to do useful work in this field of radiation in the study of solar radiations which could not be photographed heretofore nor observed visually. The bureau's recent spectrographs of the sun in the red and the invisible radiation beyond the red proved the presence in the sun of 27 known elements. In the red-region radiation, or spectra, 8 metals and 2 rare gases were examined, new work nearly completed on 10 other elemental metals, and work on rare earth elements begun.

The bureau has had success in photographing through light fogs or haze. Color screens to cut off the characteristic light of the haze in combination with red, sensitized photoplates enable the plate to record only the light from the landscape behind the haze. The pinacyanol-stained plates proved four times faster than the best commercial panchromatic plates in use. New and important fields of optical research are thus opened in photography which will demand the design of new lenses adapted to red light, the study of radiation reflection by landscapes, and special studies of sensitizing dyes.

Color standards and methods of color measurements are now being placed on an excellent scientific basis. The bureau proposes, in certain cases, to discontinue color grading in terms of material color standards which are difficult to obtain, duplicate, or certify accurately. The new method is to determine the color transmission of light of a definite wave length. This gives an essential property of the material itself independent of the color vision of the observer. The observation easily made in reproducible units eliminates arbitrary, ill-defined standards. Systematic color standards and measurements are of interest in many industries—paints, dyes, inks, textiles, paper, flour, soap, tobacco, butter, and other products—all make the field one of much commercial and economic value. The special work of the year included the color grading of papers, pyralin ivory, cottonseed oil, and other materials. The terms used in colorimetry need standardization, and the bureau has aided in systematizing not only the nomenclature, but the units, standards, and symbols.

At the request of the eye-hygiene committee of the American Medical Association, the bureau is investigating various glasses now on the market purporting to suppress harmful radiations. A technologic paper was prepared on the basis of tests of 82 samples of eye-protective glasses now on the American market. With this data, oculists or buyers may now prescribe or order glasses having any desired color transmission, acceptance being based upon color tests.

Research on quartz resulted in a new means of fixing one point on the high-temperature scale in a region not otherwise well defined; i. e., 573°.3. A very sudden change occurs in the optical properties of quartz, the sharpness of which makes it suitable for the purpose. The action of quartz in twisting the direction of vibration of light waves is known as polarization. This is the basis of polarimetry. The subject has a high theoretical value in physics and many practical uses; e. g., it is the practical basis of sugar testing. Sugar technology is based upon the readings of the polarimeter, which indicate the percentage of pure sugar in a raw sample. The bureau standardizes the quartz plates, instruments, and accessories used, and a new fund granted by Congress has recently given special impetus to the work, which is proceeding vigorously in cooperation with sugar technologists and the sugar industry.

The distribution of the bureau's standard samples of highly purified sugar for verifying polarimeters is an important means of technical control in the industry. The optical analysis of sugars at the bureau has been a useful service to the industry and in the control of the precision of sugar analyses of imported sugar for the Customs Service.

The Medical Service of the War Department requested the bureau's aid in producing certain rare sugars, about 25 in number. The bureau has tested a number of these by methods devised by careful research. The insistent demands for these rare sugars has led the bureau to study the sources and production. These sugars range in value from a few dollars to several hundred dollars a pound. The bureau has already developed successful methods for producing pure, white crystals of the so-called d'mannite sugar by double crystallization from the crude manna and at a reasonable cost.

An example of the use of abstract physics for practical purposes is the use of interference of light waves in studying the behavior of the porcelains and amalgams used to fill teeth. The bureau has for some time been investigating the expansion of such materials when exposed to changes of temperature. This calls for exact measurements of the expansion of these materials when heated. Light waves and the phenomenon of interference are used to measure this expansion with great precision. These dental materials were found to expand four times as much as the natural teeth themselves. The data will aid in the development of more perfect filling materials for the teeth.

The bureau designed and constructed or cooperated in the developement of many military optical devices. It designed a spotting camera, for example, and redesigned a triangulation camera for the Navy. The spotting camera complete with a manual of instructions was turned over to the military authorities, and the triangulation camera is now completed. The bureau designed another camera for the panoramic photographing of the inside of a machine-gun barrel. Related work included a night-firing device, a marine position finder, a tank sight, a 37-millimeter gun sight, a periscope alidade, Army binoculars, and many other instruments. The bureau also tested 2,000 binoculars, 54 lens systems, 436 samples of optical glass, and made 111 tests of miscellaneous optical devices.

Radiometry comprises the field of visible and invisible radiation. The work is mainly experimental and theoretical, but its immediate application to the industries is both direct, interesting, and important; for example, in high-temperature measurements and researches on efficiencies of light sources. The bureau's expert reported to a Government department that plain glass is as useful in greenhouses as the ribbed and hammered glasses sometimes considered for such purposes. A radiophonic system of secret signaling was developed by the use of the radiation properties of molybdenite. The sensitiveness of this material made it possible to secure a loud, musical sound by the invisible radiation of wave lengths longer than red light. A system of invisible light signals was also developed, using the ultra-violet waves. Recent use of applied radiometry was made in connection with the glass roofs of balloon hangars. On request of the War Department, the bureau recommended a substitute for the special colored glasses designed to exclude the ultra-violet rays which have serious effect on balloon fabric. The bureau's advice was that they use asphaltum varnish on plain glass, which, of course, is much more economical.

### Chemistry.

In addition to distinctly chemical standardization, chemistry is required in all fields of physical standardization. Many articles published on chemical subjects on work done at the bureau show the variety of application of chemistry in physics and the special technologies. During the year, 18,436 chemical tests were made by the bureau, largely of materials purchased by the Government. Many researches were under way during the year, among which several examples may be cited. Pure materials and their uses form a series of standardization problems. The purification of mercury is now on a routine basis. Pure methane was produced for determining accurately its heat properties. Pure ethyl alcohol was prepared for use in measuring its density and other properties.

The bureau's electrochemical work included several useful researches, such as the lead plating of gas shells, black nickel plating for military equipment, and zinc plating to protect steel from corrosion. Gas chemistry has had at the bureau certain useful applications in aircraft. Balloon fabrics were tested for gas permeability and lasting qualities, and methods and instruments were developed for conducting such tests.

A new automatic gas-analysis apparatus, constructed at the bureau, is now in operation at the Government nitrate plant at Arlington. Apparatus was also constructed to record the amount of helium in preparing the gas for use in balloons, and a set is now under construction for the large helium plant of the War Department by which 12 simultaneous and continuous analyses of helium output are automatically made. The shortage of platinum during the war led the bureau to the study of platinum substitutes and certain alloys of gold containing palladium were found suitable for many chemical operations.

The bureau has continued its interest in standardizing reagents and in the proper labeling of chemical reagents, so that the serious difficulty attending their use by chemists may be reduced. The bureau has organized an interdepartmental committee on paint-specification standardization, and a conference was held at the bureau. The first results are embodied in the Standard Specifications for Linseed Oil, recently published by the bureau. A new edition of the circular on soaps was issued.

In addition, the bureau has continued technical analyses and chemical researches on a very wide range of materials.

**Materials.**

The bureau's work in materials includes a wide range of structural and miscellaneous materials, such as metals, cement, lime, paper, textiles, rubber, leather, oils, clay products, etc.

All cement used by the Government, by Executive order, must conform to the United States Government standard specifications for cement. The cement tested by the bureau covered shipments of 6,588,923 barrels, practically double that of the previous year, and 12 times the amount tested in the year 1916–17. The rejection of 10 per cent of the cement tested shows the need for such testing. Researches were made on the properties of cement and concrete, fineness of grinding, air analysis, standard cement sieves, volume changes in finished mortars and cements, concrete oil storage, waterproofing of concrete and stucco, and the acceleration of hardening of cement. The bureau's samples of finely ground cement of definite and certified fineness of grain enables the technical laboratories of the country to standardize their own sieves accurately.

The construction of concrete ships was initiated in the bureau's cement laboratory, the chief of which became the directing head of such construction. The bureau has since continued its technical cooperation with the Shipping Board in numerous ways. During the year, a study of the cement gun, by which the material is shot in place instead of being cast, was completed and reported upon. Improved methods were developed affecting the properties and ingredients of cement and concrete and the time of mixing. A useful improvement consisted in the use of paper molds in place of the steel molds hitherto used for casting concrete test cylinders.

Lime has commercial uses not only as a structural material, but in other industries. Standards of quality for lime are quite recent. In the work on lime the bureau has had the cordial cooperation of the National Lime Association and similar organizations, all of which have committees on cooperation with the bureau. Important researches under way during the year have included the compressive strength of cement and lime mortar, the effect of hydrated lime on the properties of cement, causes of "unsoundness" in lime plasters, and the measurement of plasticity. The bureau's methods developed for the study of plasters apply also to gypsum and other wall plasters.

Rubber has such varied and important uses that the bureau endeavors to handle basic problems of the physics and chemistry of rubber and develop methods of test. Methods of determining the ingredients have been developed, and many samples of manufactured rubber goods were analyzed during the year, including balloon fabrics, rubber tires, rubber packing, hospital supplies, fire hose, and others. The bureau tested within a year samples representing the purchase of about 250,000 tires and established a local laboratory at one of the large rubber centers. Assistance was rendered to makers of solid-rubber tires in improving compounds used, and as a result a solid tire was developed which met all requirements. The possibilities of rubber research are as broad as the usefulness of the material. In the new quarters in the industrial laboratory it is expected that the work may be extended to include important and fundamental investigations.

The technology of leather is an important part of the bureau's work. A research completed during the year had to do with certain chemicals, including glucose and salts, which are put into the leather. The bureau is working in close cooperation with the Tanners' Council, the American Leather Research Laboratory, and the War Department. Special studies were made on sole leathers and on leather for shoe uppers to be used in the making of Army shoes, and also on the physical properties of harness leathers in connection with the stuffing material. Miscellaneous tests in the leather laboratory cover leather packings, waterproofed leather, and artificial leather.

The bureau cooperated in an advisory capacity in the development of specifications for leather for the General Supply Committee, the War Department, and the Panama Canal. Much progress may be expected during the coming fiscal year in this direction. In this connection, arrangements have been partially completed for installing an experimental tannery at the Bureau of Standards for use in leather research. The new laboratory provides ample space for extensive research and testing in accordance with an outlined program.

The Government uses approximately 50,000 tons of paper per year; this is bought on specification and tested at the Bureau of Standards. Five thousand samples were examined, of which 4,213 were for the Government, which included more than 19,000 separate tests. The bureau demonstrated that 700,000 bales of munitions linters left unused when the war closed could be used for the making of paper. Samples of paper were experimentally made on its paper mill to demonstrate that good paper could be made from such linters. As a demonstration, the programs of the annual convention of the Interstate Cotton Seed Crushers' Association of New Orleans were printed on paper manufactured at the bureau from cotton linters. About 700,000 bales per year are available for paper making, and, if care is taken to keep the linters clean, a still larger amount can be utilized.

The physical, chemical, and microscopic testing of textiles is an important field of the work of the bureau which has had specia, value during the war in connection with Army uniforms, blanketsl airplane and balloon fabrics, tent material, and other fabrics. The examination of English, French, and German fabrics showed that few of them were as good as the average of American manufacture. Woolen uniforms were examined for fastness of color, nature of dye, and the amount of cotton present. During the year an investigation has been in progress on sizing compounds for cotton yarns preliminary to the work on practical experiments in the bureau's cotton mill. In connection with airplane fabrics a study was made of stress in flight and new fabrics were designed and manufactured to improve serviceability. The increasing size of airplanes makes it important to have a stronger fabric. With the same object a tautness meter was designed and constructed at the bureau for the study of the wing fabrics in flight. Numerous readings taken on wing coverings of planes showed that tautness may be used to interpret the effects of humidity and temperature on the life of the fabric. With the occupancy of the new industrial laboratory, the textile section will have unusual equipment for research—a small felting unit, a complete unit of cotton machinery, and a similar outfit of woolen machines. These are of the latest manufactured design improved for the accurate requirements of laboratory work. One important object in view is the development of exact specifications for fabric, especially for the military departments. Such specifications will also be useful for other purposes, and the general results of the investigations will all be of service to the textile industry and the general public.

The testing-machine laboratory has continued a long list of useful investigations during the year, the tests numbering 3,000 in all. Some of these were extensive researches such as the test of a 150-ton floating crane for the Norfolk Navy Yard, the experimental study of electric welding for the Emergency Fleet Corporation, and technical investigations of motor-truck wheels and their behavior under stress.

### Aeronautical Instruments.

Measuring instruments are vital to control in aviation, and the standardization of such instruments is of the utmost urgency. The bureau reached mathematical solutions of the theory of such instruments, so that the results may be applied to particular cases. The failure of the metals used in the construction of aeronautic instruments to be perfectly elastic proved to be a critical source of error, and alloys were developed which are believed to be superior to the metals previously used. The bureau has tested 578 airplane instruments, completed researches on the errors of instruments, studied different types of tachometers, and determined the complete corrections for the barographs used in the flight which established the world's altitude record.

Members of the bureau's staff conducted flight tests of airplane instruments, making airplane flights in the dark to demonstrate a projection-type, night-altitude indicator. A series of high-altitude flights was made to study the oxygen-supply apparatus, the rate-of-climb indicators, the gyroscope, and other inclinometers. Tests were also made in flights across the English Channel and in the suburbs of Paris.

An interesting example of the bureau's work in technical education was the school of aeronautic instruments conducted for aviators. This included a three-weeks' lecture and laboratory course covering the theory and testing of aeronautical instruments. The data and other illustrative materials for similar courses were also furnished for the use of the Army.

### Metals.

The metallurgical division of the bureau engages in fundamental researches affecting the improvement of metals, the development of new metals, and methods of avoiding metal failures and prolonging the useful life of metals and metal products. For this purpose, the bureau has a well-equipped experimental foundry, rolling mill, metallographic laboratory, heat-treatment laboratory, chemical laboratories, and a full equipment of electrical furnaces and pyrometers. The standardization of the purity, the composition, microstructure, and heat treatment are possible only through the measured control of all the factors, such as temperature, rates of heating and cooling, pouring temperatures, etc. Many practical problems of metal failures have been solved in the laboratory and a great amount of work done on improving the quality of metals by heat treatment and the standardization of pouring temperatures and finishing temperatures.

An important output of the metal laboratory consists of specifications for metals for special uses. During the war a series of aircraft-materials standards were developed. In peace times the specifications cover the regular supplies needed by the Government departments, and special cases, such as statuary bronzes and metals for other special uses. Several cases of the bureau's aid to the metal industries will illustrate the work. Collapsible tin tubes are used for many classes of materials, and at the request of manufacturers of such tubes the bureau pointed out the several causes of defects. The behavior of aeronautic-pressure instruments depends upon the metal diaphragm. The success of several new alloys designed to correct the errors in such instruments depended upon proper annealing, for which suitable methods were developed by the metal experts. The bureau studied the deterioration of zinc-aluminum alloys used in die casting and reported upon the limitations of such material for this work. In another case the causes of certain defects in sterling-silver ware were pointed out after careful study of the ware. Manufacturers of razors and cutlery have recently requested the bureau to devise methods for measuring and defining the sharpness of fine cutting edges. Since this is practically a new field of standardization, there is little or no available or published experience to serve as a basis.

Changes in the rate of cooling observed in any metal are indications of quality and composition. The study of these is called "thermal analysis." An inexpensive method for such work was applied at the bureau during the year, a stop watch being substituted for the expensive chronograph usually used. Heat treatment is being examined with great care, and work is in active progress on a widely used structural alloy steel (containing 3½ per cent nickel). The purpose is to correlate the properties with certain tests now made throughout the country. A detailed study of high-speed steels is being made to gain knowledge of their constitution and properties and to develop a method for comparing the relative value of two cutting steels. An important investigation is under way to find suitable steels and treatments for the same for use in making precision length gauges. The important factors in this work are the determination of the resistance to wear and deformation with time, the resistance to corrosion, soundness, expansibility, and economy under varying heat treatments.

Small amounts of gases like nitrogen, hydrogen, and carbon dioxide affect the breaking strength and other properties of metals. These questions must be attacked in a fundamental way, and the work in pure metals has this study as one of its objects. Such pure metals are melted in vacuum furnaces, and the product is practically gas free. In the making of alloys uniformity is an important result to be attained, as segregation naturally is detrimental to the quality of the alloy. The bureau has conducted many studies of the "segregation" of the ingredients in the alloys. Work now in progress includes the preparation of electrolytic iron and melts or alloys prepared in vacuum, the making of pure aluminum, methods of determining gases in steel, deoxidizing agents for steel making, and the development of methods of steel analysis.

The bureau foundry is for experimental casting of metals and alloys and also is used practically as a commercial foundry supplying special castings for instrument parts required at the bureau and by other Government laboratories. This is one of the very few experimental foundries in the country, and it has many possibilities for service to industry. The work of the foundry included studies of Government bronze and its substitutes, studies of the relation of statuary bronzes to their weathering effects, efficiency studies of electric furnaces, investigation of light aluminum-casting alloys, and practical and experimental castings for laboratory use. An auxiliary investigation of molding sands of various types is of great importance to the foundry industry.

**New Industrial Laboratory.**

The branch laboratory of the bureau which has been maintained for some years at Pittsburgh, Pa., is to be discontinued and the equipment, staff, and work consolidated with the main laboratories of the bureau in Washington. On the completion of the new industrial laboratory designed to house this work, the installation began, and at this writing much of the equipment is transferred from Pittsburgh into the new quarters. In this connection, attention should be called to the excellent design of the new building and the unusual facilities which will be afforded for industrial research, facilities probably unexcelled in any laboratory. The facilities of the new laboratory include the full resources of the well developed and equipped laboratories of the scientific divisions, chemistry, heat, light, electricity, and the measures of length, mass, capacity, density, pressure, and time.

**Ceramics.**

Clay products form a whole group of useful and art industries ranging from the crudest brick and tile to the finest porcelains used in the household, including the art porcelain ware, vases and other art products. The bureau's laboratories have been able to reproduce many of the finest qualities of foreign ware, both body and glaze. Chemical porcelain ware is a type of successful work accomplished. Much remains to be done in placing the clay-products' industries on a thoroughly scientific basis, but great progress has been made.

The refractory materials used in numerous industries have been the subject of investigation at the bureau and new substances having superior qualities have been developed. Several companies have undertaken to manufacture, for example, a new type of refractory proposed by the bureau last year, which combines ✓ light weight, porosity, good heat-insulating properties, and a high refractoriness, and is especially suited for use in marine boilers as furnace crowns, and for kiln blocks for terra cotta. The bureau has been able to produce pyrometer tubes more than 7 feet in length of American porcelains, similar to those imported from Germany before the war.

The investigations of hard-fire porcelains which have been under way for three years are nearly completed. The properties of more than 300 compositions have been studied to acquire the technical data needed in the industry. Several thousand pieces of tableware were glazed and fired. The results will shed much light on practical aspects of hard-fire porcelain manufacture.

Tiles used in wall construction were the subject of an important investigation by the bureau. The results of about 250 tests are published in a bureau technologic paper. The data will be valuable for the building industries. It is found that the source of the clay profoundly affects the clay behavior. The correlation data will be complete when the results of similar tests from other laboratories are assembled. Gratifying results were obtained in the study of architectural terra cotta. Much attention was paid to examining materials in actual buildings for various periods of time. Two striking types of failure were studied and accounted for. The laboratory work included absorption tests, artificial freezing, and strength determinations of terra cotta made from various clays largely used by manufacturers. The test pieces were burned at seven different temperatures. The resulting data will soon be announced in a final report covering all the work of the bureau on this building material.

Two technologic papers have been issued on the principles of iron enameling and researches are under way to solve problems met with in the manufacture of such materials.

The new industrial laboratory will give unusual facilities for the work in clay products. All of the contracts for the new kilns and furnaces have been let, the machinery has been purchased, and the installation of the equipment has been begun.

### The Bureau and Industrial Progress.

The Bureau of Standards occupies a pivotal position in industrial reconstruction following the war. The great lesson of the war was that standardization was a first essential to efficient warfare. War industry differs from the industries of peace mainly in its urgency. The fundamental technical knowledge and requirements are similar. The military work of the Bureau of Standards during the war, therefore, will be of value to the industries during the critical days to come. The applications of science to industry are now recognized as of priceless value by the leading countries of the world. For this reason England, Australia, and Japan, among others, have on a new and large scale decided upon national programs of scientific research on the vital problems of industry. There is some danger lest we miss the full lesson of the war while other nations make prompt application.

Technical experts, societies, and the industries begin to realize the supreme importance of standardization, and the era of standardization may be said to have fairly begun. The bureau is represented on practically all of the great standardizing committees of the technical societies and is working in close cooperation with them. For the Government the bureau is a scientific advisor on the subject of standard specifications and has performed this service for practically every department and governmental agency, notably the War Department and the General Supply Committee.

In many cases the Bureau of Standards conducts fundamental researches in the laboratory on points which the specifications disclose. It is only by such research that it is possible to formulate standards of quality and performance of materials and appliances. The universal interest in standards reflects the growing appreciation of standardization as a means of industrial progress. The annual review of existing specifications for the purpose of incorporating new knowledge has had a most fruitful effect in stimulating the prompt application of new scientific knowledge.

It is doubtful whether there is another subject as fruitful of improved economy and efficiency as the standardization which is basic to all industry. It is the standard of quality which determines the materials to be used, the form which they take, and the processes by which they are produced in the factory. It is also the standard of performance which is the user's ultimate test. In other words, standardization involves nothing less than the complete technical control of industry, by which is meant that modern industry must be based upon scientifically ascertained standards whether of measure, of quality, of performance, or of practice. From a national point of view, the work of the Bureau of Standards, therefore, is directed toward making itself as effective as possible in stimulating and in actively cooperating by research and investigation in all standardizing movements in which its cooperation is sought. The annual report of the Bureau of Standards shows many interesting examples of the variety and usefulness of this work.

## BUREAU OF THE CENSUS.

(SAM. L. ROGERS, *Director*.)

The end of the fiscal year 1919 marked the close of the seven-year intercensal period during which the Bureau of the Census carried on numerous lines of statistical work at decennial, quinquennial, biennial, annual, quarterly, monthly, and semimonthly intervals, as prescribed by law; and on July 1, 1919, began the three-year decennial census period, within which time censuses of the population, agriculture, manufactures, mines and quarries, oil and gas wells, and forestry and forest products of the United States will be taken, compiled, and published.

During the fiscal year 1919 the Bureau of the Census carried on the compilation of the results of its quinquennial census of electrical industries; completed the work on its decennial inquiries relating to transportation by water and shipbuilding; brought well toward completion the preparation of its decennial report on religious bodies; completed and published a special report on marriage and divorce; conducted the regular annual inquiries relating to births, deaths, States, and municipalities; published quarterly statistics of stocks of leaf tobacco; made monthly and semimonthly collections and publications of statistics on cotton, cotton seed, and cotton-seed products; made special enumerations of the population in four counties; carried on the publication of weekly mortality reports for certain large cities; compiled statistics relating to the mortality from the influenza epidemic; performed a large amount of war work for other governmental establishments; complied with numerous requests for information; and made detailed preparations for taking the Fourteenth (1920) Decennial Census.

The work done along the above lines during the fiscal year and since its close is described below.

### CURRENT AND COMPLETED WORK ON STATUTORY INQUIRIES.

**Electrical Industries.**

This quinquennial inquiry, covering central light and power stations, electric railways, telephones and telegraphs, and municipal electric fire-alarm and police-patrol signaling systems, was made as of December 31, 1917.

The greater part of the data were obtained through correspondence, but it was necessary to send a number of men into the field to obtain information. The field canvass was begun in April, 1918, and was substantially completed in the following December.

Preliminary reports pertaining to the several inquiries covered by the canvass were prepared and issued. The final reports on telegraphs and on electric fire-alarm and police-patrol signaling systems were issued in the form of a single bulletin on July 19, 1919; and the work on the reports for the other inquiries is nearly completed.

### Transportation by Water.

This decennial inquiry was made as of December 31, 1916. In order to avoid the disclosure of information of value to the enemy, the report was not made public during the war. After the signing of the armistice the report was completed and sent to the printer, and will be ready for distribution in the near future.

### Shipbuilding.

Statistics for this industry were collected in connection with the last quinquennial census of manufactures, covering the calendar year 1914, and a further canvass was made in conjunction with the census of transportation by water, taken as of December 31, 1916. Although the results of these two investigations were compiled and the preparation of the combined report completed prior to the beginning of the fiscal year 1919, they were withheld from publication because of the inadvisability of giving out the information during the war. The figures, however, were placed immediately at the disposal of the Shipping Board and other war agencies of the Government. In January, 1919, the manuscript was sent to the printer, and the report was issued, in bulletin form, on May 16, 1919.

### Religious Bodies.

This decennial inquiry covered the calendar year 1916. The work was done almost entirely through correspondence. The preparation of the report was frequently interrupted by war work. On May 2, 1918, the bureau issued preliminary figures, subject to correction, showing the basic facts, and on January 17, 1919, a revision of the first statement was published presenting additional statistics. The complete report is being issued in the form of two bound volumes having a total of 1,318 pages.

## Vital Statistics.

*Births.*—The "birth-registration area," which, when established in 1915, comprised 10 States and the District of Columbia, approximately 31 per cent of the total population of the United States, grew rapidly, until in 1917 it embraced 20 States and the District of Columbia, about 53 per cent of the country's population. No changes have been made since 1917. During the year 1919 tests were made in Illinois and Mississippi, but the birth registration in both States failed to measure up to the bureau's standard of 90 per cent of completeness.

A press summary of the birth-statistics report for 1917 was issued in June, 1919, and work is progressing on the report for 1918.

*Deaths.*—The "death-registration area" now comprises 30 States, the Territory of Hawaii, the District of Columbia, and 23 cities in nonregistration States, and contains approximately four-fifths of the population of the United States. The most recent additions are Illinois and Louisiana, admitted for the year 1918, and Mississippi, admitted for 1919.

A press summary giving statistics of deaths covering the calendar year 1917 was issued June 25, 1919. The annual mortality report for 1917 has been completed.

*Weekly Health Index.*—The publication of the Weekly Health Index, inaugurated in October, 1917, giving mortality reports for 46 of the largest cities of the country, has been continued. During the epidemic of influenza and pneumonia, additional sheets were included, which gave the number of deaths resulting from those causes. Beginning with the issue for June 17, 1919, there have also been presented in each week's issue statistics, obtained from the leading industrial insurance companies, showing number of policies in force, total number of death claims, and number of claims per 1,000 policies in force.

*Need of Federal legislation providing for registration of births and deaths.*—In the matter of birth and death registration the United States has not kept pace with many of the other countries of the world. This condition is due to the fact that registration has been left to the control of the State governments, many of which have failed to establish and maintain adequate systems of recording births and deaths. The practice of the Census Bureau is to admit to the birth-registration area those States, and to the death-registration area those States and those cities in nonregistration

States, in which the bureau's tests indicate the registration to represent at least 90 per cent of all births, or of all deaths, as the case may be, if the registration systems justify the expectation of a more nearly complete registration in the future.

Thus far the only legislative action taken by the Federal Government toward the improvement of our vital statistics is found in a joint resolution of Congress, approved February 11, 1903, requesting the State authorities to cooperate with the Census Bureau in securing a uniform system of birth and death registration. The bureau has achieved some success in arousing the interest of the States in the matter. Under present conditions, however, it is likely to be many years before the last one of the 48 States enacts and properly administers adequate registration laws. It will thus be necessary, if the birth and mortality records of the country are to be reliable, permanent, and readily available for reference, to provide for a comprehensive system of Federal control and supervision.

### Financial Statistics of Cities.

The report presenting financial statistics of cities having over 30,000 inhabitants, for the fiscal year 1918, has been completed. This report presents detailed statistics of revenues, expenditures, value of municipal properties, municipal indebtedness, assessments, and taxation; and also gives certain data relating to governmental organizations. The field and office work on the 1919 inquiry is now in progress, and it is expected that copy for the report will be sent to the printer early in 1920.

### General Statistics of Cities.

In addition to its reports giving financial statistics of cities, the Census Bureau issues reports on various phases of municipal governmental activities, in addition to those pertaining to finances, under the title "General Statistics of Cities." For 1918 the subject covered under this head was municipal markets, and on July 23, 1919, the complete report was published in the form of a 56-page bulletin. The subject is a timely one, and the information presented will be of value to cities that are contemplating the establishing of municipal markets.

### Financial Statistics of States.

The report presenting financial statistics of States for the fiscal year 1918 has been completed. This report follows closely the lines of those giving financial statistics of cities. Work on the inquiry for the fiscal year 1919 is now in progress, and it is expected that copy for the report will be ready for the printer early in 1920.

### Cotton and Cotton Seed.

During the fiscal year the Bureau of the Census conducted its regular inquiries in regard to cotton and cotton seed. In addition to an annual bulletin on cotton production and distribution for the season of 1917–18 and a pamphlet giving complete statistics of cotton ginned from the crop of 1918, there were issued 10 reports relating to cotton ginned to specified dates during the ginning season; 12 reports, at monthly intervals, on cotton consumed, imported, exported, and on hand, and active consuming cotton spindles; and another monthly series relating to cotton seed received, crushed, and on hand, and cottonseed products manufactured, shipped out, and on hand. The pamphlet presenting the final figures on cotton ginned from the crop of 1918 (together with data for earlier years) was distributed in time to be of use in making comparisons between the ginnings from the crop of 1919 and those for corresponding periods in earlier years.

### Stocks of Leaf Tobacco.

Four reports on stocks of leaf tobacco held by certain classes of manufacturers and dealers were published at intervals of three months. In addition, Bulletin 139, "Stocks of Leaf Tobacco: 1918," was prepared and distributed. This bulletin, which presents data contained in the quarterly reports, with comparative figures for earlier years and various other statistical information pertaining to the tobacco industry, is the second of an annual series designed to compile for ready reference the statistics of the various phases of the tobacco industry published by the several Federal bureaus.

### Official Register.

Preparations were begun during the latter part of the year for the compilation of the July 1, 1919, edition of the Official Register of the United States, which consists mainly of a directory of Federal employees, showing name, designation, compensation, etc.

## SPECIAL AND MISCELLANEOUS LINES OF WORK.

### Marriage and Divorce.

Marriage and divorce statistics for the calendar year 1916 were collected in 1917. At the close of the fiscal year 1918 the preparation of the report had been substantially finished. A press summary was issued March 20, and the report itself was published April 7, 1919. The work of compilation and preparation for printing was delayed somewhat by war conditions.

### Special Censuses of Population.

Special censuses of the population of Okmulgee, Ottawa, and Tulsa Counties, Okla., were taken, at local request and expense, in August, 1918, December, 1918, and January, 1919, respectively. A special census of Charles County, Md., was taken in March, 1919, at the request of the Secretary of the Treasury, in order to determine the effect of the recent influenza epidemic therein. The work was done in cooperation with the Public Health Service.

### Statistics of Fats and Oils.

In December, 1918, the monthly collection of data in regard to the production, consumption, and stocks of fats and oils was discontinued by the Food Administration. In view of the need for reliable information concerning these commodities during the reconstruction period, the Bureau of the Census was authorized to collect and publish, quarterly during the calendar year 1919, similar statistics. This work is now in progress.

### United States Life Tables.

As stated in my last report, the bureau computed a series of "life tables" supplementary to the series issued in 1916, exhibiting mortality conditions in certain areas for the years 1890 and 1901 and during the decennium 1901–1910. These tables, which provide valuable comparative data for use in studying changes in mortality rates, will be included in a new edition of the life tables, materially enhancing their value. In connection with certain of the original tables there will be given commutation columns, annuities, and premiums at various rates of interest; and the data on which the various tables were based, the derivation of the theory, and an explanation of the methods of computing them will also be shown.

### Special Investigation of Influenza Epidemic.

A compilation of data in regard to the mortality resulting from the epidemic of influenza and pneumonia during the last four months of 1918 was made for the States of Indiana and Kansas and the city of Philadelphia. The results, in the form of tables and graphs, are now ready for publication.

Thanks are due to the United States Public Health Service for its generous financial assistance in this work.

### International Statistical Year Book.

At the request of the secretary of the International Statistical Institute at The Hague, the Bureau of the Census compiled detailed data relating to the United States as a whole and to the States individually for inclusion in the International Statistical Year Book (Annuaire Internationale de Statistique). The work was begun in February, 1919, and completed in the following June.

### Statistical Directory of State Institutions.

During the fiscal year 1918 the bureau brought to substantial completion the compilation of a statistical directory of State institutions for the dependent, defective, and delinquent classes; but because of the great amount of war work and other current work, the publication of this directory has been delayed. It is now in the hands of the printer, however, and will be issued at an early date.

### Searching of Census Records to Determine Ages.

During the fiscal year 2,315 searches of census records were made for the Pension Bureau, in order to determine the ages of applicants for pensions and increases of pensions. Other searches were made for genealogical purposes and for the purpose of supplying statements as to the ages of children affected by the child-labor laws. A vast amount of work was done in searching the records to establish the ages of men who had not registered for military service, but were believed to be within the prescribed ages.

### Miscellaneous Information Supplied Other Governmental Agencies and Outside Organizations.

Numerous compilations of statistical information from the bureau's records were made in compliance with requests received from other Federal bureaus and from private concerns, consisting chiefly of industrial statistics. Among the organizations for which they were made were the Chamber of Commerce of the United States; the U. S. Tariff Commission; the Office of the Surgeon General, War Department; the General Electric Co.; Power Plant Engineering (periodical); the Sinclair Refining Co., Chicago; the Southwestern Electrical & Gas Association, Dallas, Tex.; and the National Association of Cotton Manufacturers.

## WAR WORK.

### Census of Materials and Commodities for Use of War Agencies.

This work, which was authorized on April 8, 1918, was described on pages 92 and 93 of my report for 1918. It was undertaken to secure statistical information needed by the War Trade Board, the War Industries Board, the Shipping Board, the Food Administration, the Council of National Defense, and the Commercial Economy Board, in regard to the production and stocks on hand of the following-named classes of commodities, listed in the order in which work upon them was begun: Kapok fiber; jute; leather stocks; boots, shoes, and manufactured leather goods; silk; antimony; graphite crucibles; wool manufactures—machinery and production; and iron and steel products. For each of these classes of commodities, except leather stocks, boots, shoes, and manufactured leather goods, and graphite crucibles, only one report was made, beginning with that for kapok fiber, which referred to May 1, 1918. For leather stocks, monthly reports relating to the last day of each month, May to December, 1918, and quarterly reports, as of March 31 and June 30, 1919, have been compiled; for stocks of boots, shoes, and manufactured leather goods, the reports referred to the last day of each month, June to December, 1918, and to March 31 and June 30, 1919; and for graphite crucibles, two reports were issued, as of June 30 and September 30, 1918.

The collection of statistics of leather stocks and stocks of boots, shoes, and manufactured leather goods is of great importance as a conservation measure. The collection of these statistics, at quarterly intervals, was accordingly continued at the request of the War Industries Board and upon the recommendation of the war service committee representing the shoe and leather industries of the United States Chamber of Commerce. A simplified form of schedule was used for the quarterly statistics.

Statistics for all the war commodities covered by the several inquiries have been revised and rearranged for printing in a condensed form more convenient for reference. This is designed to be the final presentation of these statistics, and will constitute a permanent record of the census of war commodities.

### Census of Commercial Greenhouses.

This inquiry was made at the request of the priorities division of the War Industries Board, which desired the information for use in connection with fuel restrictions.

### Work Done for Provost Marshal General.

The 293,788 enlistments in the Navy, the Naval Reserve, the National Naval Volunteers, and the Marine Corps during the period from April 2, 1917, to June 30, 1918, were allocated by the Census Bureau. Estimates were prepared in July, 1918, of the number of British subjects in the United States subject to draft under the terms of the conventions concluded between this country and Great Britain, and also of the numbers of men in the United States from 18 to 20 and from 32 to 45 years of age, inclusive.

### Determination of Ages of Registrants.

District attorneys and other officials of the Department of Justice were, at their request, supplied with age certificates for men who, although of military age, had not registered for the selective draft; and men requesting it were given statements showing their ages as indicated by the census records.

### Liberty Loan Work.

In connection with the Liberty Loans made during the fiscal year, the Bureau of the Census aided the Treasury Department by sending out literature to various mailing lists.

### Compilation of Statistics Relative to Foreign Countries for Peace Conference.

This compilation comprised statistics of the movement of cereals, salt, oil, coal, and wood on the railways and waterways of Russia in 1908, 1909, and 1910, the latest years for which figures were available; a tabulation showing the distribution of manufacturing establishments and wage earners in Austria by industries and factory-inspection districts; and statistics in regard to the exports and imports of countries and colonial possessions in Africa.

### Information for U. S. Shipping Board.

At the request of the U. S. Shipping Board, detailed tables were prepared showing the population and value of agricultural products within a radius of 100 miles of each of 28 cities located on the Atlantic, Pacific, and Gulf coasts.

### Miscellaneous War Work.

In addition to the foregoing, the Census Bureau performed numerous small amounts of war work for the Post Office Department, the Navy Department, the Department of Labor, the Bureau of Foreign and Domestic Commerce, the Fuel Administration, the Federal Trade Commission, the Telephone and Telegraph Administration, the Office of the Chief of Engineers, the General Engineer

Depot, the Office of the Director of Military Aeronautics, the Emergency Fleet Corporation, the Railroad Administration, the War Industries Board, the War Trade Board, the Capital Issues Committee, the Central Statistical Clearing House, the Employment Service, the Reconstruction Survey, the War Service Committee of the Rubber Industry of the United States, and the American Electric Railway Association War Board.

### Members of Force Enlisted and Drafted Into Military and Naval Services.

During the fiscal year 25 office and field employees of the Census Bureau entered the military and naval services (not including those who joined as Army field clerks). The total number who entered those services from the outbreak of the war to the signing of the armistice was 79.

## PUBLICATIONS ISSUED.

Following is a list of the more important reports published by the bureau during the fiscal year and since its close. In addition, various bulletins and press summaries have been issued.

| Class and title (quarto except as otherwise indicated). | Date issued. | Pages. |
|---|---|---|
| Deaf-mutes in the United States | July 5, 1918 | 221 |
| Stocks of leaf tobacco (octavo)—Bulletin No. 136 | July 17, 1918 | 44 |
| Statistics of fire departments of cities having a population of over 30,000: 1917 | Aug. 13, 1918 | 105 |
| Census of the Virgin Islands of the United States: Nov. 1, 1917 | Aug. 27, 1918 | 147 |
| Specified sources of municipal revenues: 1917 | Aug. 28, 1918 | 140 |
| Mortality statistics: 1916 | Sept. 27, 1918 | 543 |
| Financial statistics of cities having a population of over 30,000: 1917 | Oct. 5, 1918 | 373 |
| Financial statistics of States, 1917 | Oct. 10, 1918 | 129 |
| Negro population in the United States: 1790–1915 | Oct. 28, 1918 | 844 |
| Prisoners and juvenile delinquents | do | 535 |
| Birth statistics for the registration area of the United States: 1916 | Nov. 6, 1918 | 96 |
| Cotton production and distribution, season of 1917–18—Bulletin No. 137 | Jan. 1, 1919 | 135 |
| Census of manufactures, 1914—Vol. I, reports by States and principal cities [a] | Feb. 26, 1919 | 1,677 |
| Marriage and divorce, 1916 | Apr. 4, 1919 | 47 |
| Shipbuilding (including boat building): 1916 and 1914 | [b] May 16, 1919 | 35 |
| Census of manufactures, 1914—Vol. II, reports for selected industries and detailed statistics for industries by States [a] | July 2, 1919 | 1,047 |
| Census of war commodities: | | |
| Statistics of leather | Dec. 12, 1918 | 11 |
| Iron and steel | Jan. 31, 1919 | 16 |
| Antimony, and graphite crucibles | Apr. 4, 1919 | 10 |
| Textile fibers—wool, silk, jute, and kapok | Apr. 17, 1919 | 16 |
| Four reports, in card form, relating to stocks of leaf tobacco | July 29, 1918 to Apr. 30, 1919 | 4 |
| Thirty-four reports, in card form, relating to cotton and cotton seed | June 14, 1918 to June 19, 1919 | 34 |

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[a] The various reports bound together in these volumes had previously been published separately.

[b] Withheld from earlier publication for military reasons.

## PREPARATIONS FOR THE FOURTEENTH CENSUS.

### Fourteenth Census Law.

As set forth in my annual report for 1918, a bill to provide for the Fourteenth and subsequent decennial censuses was drafted by the Census Bureau and submitted to the House Committee on the Census. The bill was passed by the House of Representatives July 2, 1918, and by the Senate, with amendments, January 14, 1919; the conference report was adopted by the Senate February 28, 1919, and by the House March 3, 1919; and the bill was approved by you on March 3, 1919. In many respects it follows the lines of the Thirteenth Census legislation, but there are departures in regard to a few important features and numerous unimportant ones. The most significant points of difference are as follows:

*Section 1.*—Insertion of provision for census of forestry and forest products.

*Section 6.*—Reclassification of clerical salaries, so as to provide a much larger number of classes, differing from each other by only $60 per annum between $900 and $1,440, and by $120 per annum between $1,440 and $1,800; increase in compensation of clerical and subclerical employees generally; and provision for preference to honorably discharged soldiers, sailors, and marines, and their widows, in making appointments to positions in all executive departments and independent governmental establishments.

*Section 7.*—Provision, applying to Federal service generally, requiring Civil Service Commission to examine applicants temporarily absent from the places of their legal residence without requiring them to return for the purpose of examination; and provision authorizing selection of temporary Census employees from reemployment registers established by Executive order of November 29, 1918.

*Section 8.*—Omission of provision for securing information in regard to unemployment on census date and during preceding calendar year and in regard to Civil War veterans; insertion of provision for obtaining information as to encumbrances on homes and farms; omission of provision for enumeration of inmates of institutions for dependent, defective, and delinquent classes (this inquiry to be made after close of census period); inclusion of inquiry as to sex of farm operators; amplification of irrigation inquiry; and addition of drainage inquiry.

*Section 9.*—Provision for appointment of supervisors by Secretary of Commerce, upon recommendation of Director of Census, instead of by President, by and with advice and consent of Senate.

*Section 20.*—Change of census date from April 15 to January 1; reduction of minimum size limit for cities in which enumeration must be completed within two weeks, from 5,000 to 2,500.

*Sections 21–24.*—These sections, which provide penalties for violations of the Fourteenth Census act, have been so drawn as to make them more effective and more readily enforceable than the corresponding sections of the Thirteenth Census act.

*Section 31.*—Provision for mid-decennial census of agriculture, to be taken in 1925 and at 10-year intervals thereafter.

*Section 32.*—Provision for biennial census of products of manufacturing industries, beginning in 1921.

### Joint Advisory Committee of American Statistical and Economic Associations.

At my invitation, under date of November 18, 1918, the presidents of the American Statistical and American Economic Associations appointed a joint committee to advise the Director of the Census and the Department of Commerce in connection with the work of the Fourteenth Census. This committee was composed of six members, namely:

Representing American Statistical Association—W. S. Rossiter, chairman, formerly chief clerk, Bureau of the Census, now president Rumford Press, Concord, N. H.; Prof. Carroll W. Doten, Massachusetts Institute of Technology; Dean Edwin F. Gay, Harvard University.

Representing American Economic Association—Prof. Wesley C. Mitchell, Columbia University; Prof. E. R. A. Seligman, Columbia University; Prof. Walter F. Willcox, Cornell University.

The joint advisory committee has thus far held six meetings. It has given very careful consideration to all phases of the census work thus far planned, and has made a number of helpful recommendations. The members of this committee have rendered valuable assistance in connection with the preparatory work of the Fourteenth Census.

### Field Force.

Continental United States (exclusive of Alaska) was divided into 372 supervisors' districts. These districts, outside the large cities, were as a rule coextensive with the congressional districts; and each of the large cities was placed under the charge of a single supervisor, with the exception of New York City, which was divided into four districts.

At the Thirteenth Census the enumeration was made as of April 15, and at earlier censuses as of June 1, but under the existing law the next and subsequent censuses will be taken as of January 1. This necessitates the appointment of the supervisors at an earlier date than heretofore, and with the least possible delay.

In regard to the selection and recommendation for appointment of candidates for supervisors, I issued, under date of March 4, 1919, the following instructions to the Director of the Census:

> Conforming to the assurances given the President in my letter to him of March 3, you will please be guided by the following instructions respecting appointments to the post of supervisor in connection with the taking of the Fourteenth Census of the United States:
>
> A test examination, of which a record will be kept, is to be required for appointment to the post of supervisor. In addition to this, a careful personal inquiry is to be separately made respecting the qualifications of each candidate. Of this inquiry, also, a record will be kept.
>
> In making appointments from those who shall have passed the test examination and the separate inquiry as to qualifications, preference is to be given to those candidates who have had executive, administrative, statistical, or accounting experience and to those who have had charge of bodies of men as administrators, provided in all cases that men with the experience stated possess the other qualifications necessary.
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> You will arrange to give notice to the above effect to every candidate applying for appointment and to his sponsors, and no candidates are to be selected for appointment who do not pass both the test examination and the personal inquiry.
>
> You are requested to ask the Civil Service Commission to prepare the blanks for the test examination or to cooperate with you in the preparation of them. You will welcome the assistance of the Civil Service Commission in this and in any other respect in which they can be helpful to you.
>
> It is my earnest desire, as I know it is your own, that this census shall be an example in its quality, as well as in its promptness. I need hardly say that neither result can be had unless the supervisors are selected with special care to their individual fitness for their task. I am depending on you as the responsible officer in immediate charge of the work to see that every precaution is taken to achieve this result. In particular, the appearance as well as the fact of political patronage are to be avoided, and fitness for the work to be done will be the controlling factor in the appointments.

Under date of March 17, 1919, the bureau issued a press notice announcing the date of the coming census, the approximate number of supervisors to be appointed, and the method of their appointment, and quoting the above instructions. Approximately 5,500 persons were supplied, upon request, with application blanks for the position of supervisor, similar to the forms used by the Civil Service Commission for "nonassembled" examinations; and about 2,200 of these applications were filled out and returned to the bureau. A suitable scheme of rating was devised, the papers were graded, selections were made, and a list of candidates recommended to me for appointment; and during August the appointments were made and announced through the public press.

The following letter, which I addressed to the Director of the Census under date of July 12, 1919, in regard to political activity on the part of supervisors and enumerators, has been embodied in the instructions to these classes of census employees:

> The taking of the Fourteenth Census involves the appointment of some four hundred supervisors, upon whom in turn will rest the serious duty of selecting and appointing many times that number of enumerators. The success of the census will depend upon the efficiency, impartiality, and the strict attention to duty of the supervisors and upon the intelligence of the enumerators and their faithful devotion to the important public business which is to be placed in their hands.
>
> The vast country-wide system thus created can be perverted to political uses if both supervisors and enumerators are not forbidden to use it as an instrument for influencing either local or general elections, or primaries, in the interest of particular candidates or parties.
>
> The work of the census itself is a sufficient task to tax the powers of those concerned in it, and it is a reasonable requirement that whoever accepts an appointment as supervisor or enumerator shall, during the term of his employment as such, strictly avoid any active part in politics.
>
> Attention is therefore directed to the following order of the President of the United States, dated August 16, 1909:
>
> "I therefore order that, in the preparation of regulations for the taking of the census, you and the Director of the Census embody therein a provision that any supervisor or enumerator who uses his influence with his subordinates or colleagues to assist any party or any candidate in a primary or general election, or who takes part, other than merely casting his vote, in politics, National, State, or local, either by service upon a political committee, by public addresses, by the solicitation of votes, or otherwise, shall be at once dismissed from the service.
>
> "I wish to make this regulation as broad as possible, and wish it enforced without exception. It is of the highest importance that the census should be taken by men having only the single purpose of reaching a just and right result, and that the large amount of money to be expended in the employment of so vast a machine as the census shall not be made to serve the political purposes of any one."
>
> The above order, applicable to the census of 1910, is now confirmed and made applicable to the work of the census of 1920. It is an essential factor in the appointment of every supervisor and enumerator and is to be obeyed by those officers in letter and in spirit. Departure from it will be considered as warrant for dismissal from the service, as therein stated.

The enumerators will be selected by the supervisors, with the approval of the Director of the Census. Each candidate will be required to undergo a practical test.

### Office Force.

It is estimated that the total office force of the Fourteenth Census will reach at its maximum about 4,000, as against 3,738 at the last census. The estimated increase is proportionally smaller than the increase in the work to be done, but it is expected that certain changes in organization, improvements in methods, and developments in tabulating machinery will make possible some increase in the average amount accomplished per employee.

Of the 4,000 officials and employees who will compose the census force when at its maximum, between 3,000 and 3,500 will be temporary clerks. Most of these clerks will be appointed as the result of special examinations to be conducted by the Civil Service Commission this fall throughout the United States; and the remainder will be secured (1) by selection from the reemployment registers of the Civil Service Commission established under authority of the Executive order of November 29, 1918, as amended April 30, 1919; (2) by selection from the registers maintained by the commission for the departmental service generally; and (3) by transfer, reinstatement, etc., under the civil-service rules.

The office force on August 31, 1919, comprised 23 officials, 717 clerical employees, 39 subclerical employees, 30 mechanical-laboratory employees, and 42 special agents for general field work, etc., a total of 851. In addition, there were employed throughout the cotton belt 694 local special agents to collect statistics of cotton and cotton seed. These agents perform their work only at intervals and are paid on a piece-price basis.

### Preparation of Schedules, Etc.

The various schedules, instructions, and other forms to be used at the coming census have been prepared, and most of the population and agricultural schedules have been distributed to the supervisors. In connection with the preparation of the agricultural schedule, the division of agriculture held numerous conferences with representatives of the various governmental departments interested in agricultural statistics, as well as with professors in agricultural colleges, and representatives of agricultural periodicals and of farmers' associations. As a result, a general farm schedule was formulated which has been very widely indorsed and has received the unqualified approval of the joint advisory committee of the American Statistical and Economic Associations.

### Encumbrances on Homes and Farms.

Section 8 of the Fourteenth Census act contains a provision, inserted by the Senate, for ascertaining the amount of encumbrances on mortgaged homes occupied by their owners, of which in 1920 there may be approximately 4,000,000. In order to obtain a part of the information required—that relating to the market value of the home, the amount of encumbrance, and the annual rate of interest—it will be necessary to use a special schedule. It is estimated that the additional cost of collecting and compiling this information will be at least $1,000,000.

### Outlying Possessions.

The Fourteenth Census act provides for censuses of Alaska, Hawaii, and Porto Rico, to be taken by the Bureau of the Census, and also for censuses of Guam, Samoa, and the Panama Canal Zone, to be taken by the respective governors of those possessions in accordance with plans prescribed or approved by the Director of the Census. In taking the census of Alaska the Bureau of the Census will cooperate with the Bureau of Education. The work will be done under the direction of William T. Lopp, in charge of the Alaskan division of the Bureau of Education. Arrangements are being made, through the War and Navy Departments and the Panama Canal officials, with the Governors of Porto Rico, Guam, Samoa, and the Canal Zone, for taking the censuses of those possessions.

### Mechanical Equipment.

*Work in mechanical laboratory.*—The object of the mechanical laboratory, to have produced or to have on hand at the close of the fiscal year 1919 all parts entering into the construction of certain tabulating machinery for the work of the Fourteenth Census, has been practically attained.

Five automatic tabulating machines have been completed and tested, of which four are in actual use; and the remainder of the equipment of tabulating and sorting machines will be completed on or before February 1, 1920.

The original estimates pertaining to the card sorting machines took into consideration merely the work of overhauling. It was later found expedient to introduce some radical changes in design and method of operation, and the result has been the production of a practically new and much more efficient machine.

*Integrating counter.*—In my last two reports I have referred to the progress of the development of an "integrating counter"—that is, a counter which will record and add numbers instead of mere units, thus performing automatically the work done by the operator of an adding machine—for use in tabulating certain classes of census data. The numbers will be indicated on cards by punch marks, the cards will be fed into the machine, and the numbers will be automatically totalized. Several sets of figures can be totalized at the same time. The principal advantage to be derived from the use of the integrating counter lies in the facility with which the data may be regrouped or rearranged.

Work on the integrating counter, which began on July 6, 1917, is still in progress. The first model has been completed as an experimental machine, and it has added and recorded numbers as indicated on punched cards at the rate of from 20,000 to 25,000 cards a day. A complete set of drawings and all patterns necessary for manufacturing this type of machine have been made.

A tentative card system for tabulating part of the manufactures census has been developed and will be tested.

## BUREAU OF FISHERIES.

(Dr. Hugh M. Smith, *Commissioner.*)

### General Considerations.

While the work of the Bureau of Fisheries has been resumed along normal lines, following several years of special adaptation to war requirements, changed economic conditions resulting from war demand, and are receiving, serious attention.

It is quite apparent that, owing to food shortage and the active campaigns that have been waged for the purpose of offsetting that shortage, the use of aquatic products has acquired a more prominent place. That place can be enlarged and firmly established with marked benefit to the entire country. The bureau seeks to render this service. It is incumbent on Congress to authorize and support the effort.

All the vessels placed at the disposal of the Navy during the war have been returned, and the use that the Navy was making of the marine biological stations at Woods Hole, Mass., and Beaufort, N. C., has been relinquished.

The discrimination against this service in the matter of the attendance of technical employees of the bureau at meetings of societies should be removed.

The bureau deserves liberal, whole-hearted, unsuspicious treatment at the hands of Congress. It is rendering a large public service in a modest, loyal, effective manner. It more than pays its own cost in each of several ways. The direct revenue accruing to the Government through the operation and administration of laws affecting the fisheries of Alaska exceeds all the appropriations for the support of the bureau. The actual revenue returns for the operations of the calendar year 1918 will be found to exceed $2,865,000, a sum which includes the tax levied on preserved salmon, fish oil, and fish fertilizer; the net sales of fur-seal skins taken on the Pribilof Islands; the net value of fox skins from the same locality; the returns from other Alaskan products and enterprises coming within the purview of the Department; and fines resulting from convictions for violations of law (the amount involved in this last item being small).

Of even more importance is the indirect and immeasurable value of the food fish produced and planted and the food fish rescued and restored to the waters. Any attempt to represent by dollars the value of the fish-cultural work would be futile; but it may be noted that if the hatcheries had been commercialized their output in the fiscal year 1919, together with the fishes salvaged from the overflowed lands of the Mississippi Valley, would have had a market value of not less than $2,000,000.

No cognizance need be taken, in this connection, of the commercial value to individuals and industries of the biological and technical inquiries conducted by the bureau, although this is great.

### Planting the Waters.

The comprehensive and varied operations of the Bureau of Fisheries in artificially propagating food fishes and planting them in suitable waters have reached a high degree of effectiveness. This work has had a gradual development in response to the urgent needs of the country, and meets with hearty public support because of the obvious benefits. There is demand for an extension of operations into sections not adequately covered by existing hatcheries, more particularly for the purpose of maintaining and increasing the supplies of common species like the catfishes and buffalofishes that can be produced in large quantities and are wholesome food.

The output of the fish-cultural stations during the fiscal year 1919 aggregated over 5,875,000,000 fish and fish eggs, most of the latter being consigned to State hatcheries. The distribution was more extensive than ever before, exceeding the best previous record of 1917 by more than 715,000,000 and surpassing the year 1918 by 1,779,000,000.

### Humpback Salmon in Maine.

In March, 1917, over 900,000 humpback salmon were planted in Maine waters, that had become unsuitable for the Atlantic salmon. This year the results of this introduction of a Pacific species are becoming apparent. It is reported that the fish have been seen in thousands in the Dennys and Pembroke Rivers, and the herring weirs in Passamaquoddy Bay have taken considerable numbers. The success of this experiment, for which there is every reason for the bureau to be gratified, is confirmed by the taking of nearly 400,000 eggs from humpbacks in the rivers named, which will be incubated at the hatchery at Craig Brook, Me.

### Rescue of Stranded Food Fishes.

Too much stress can not be placed on the importance of the work of rescuing food fishes from the overflowed lands in the basin of the Mississippi River and its tributaries. All of the fish left behind when the freshet waters subside inevitably succumb to the drying or freezing of the pools or ponds in which they congregate unless rescue parties seine out the cut-off waters and restore the fishes to the main streams.

The aggregate number of salvaged fishes in the summer and autumn of 1918 was upward of 55,800,000, comprising practically every species of food fish of the Mississippi Valley. About 600,000 of the rescued fishes were distributed by the bureau's cars to outside waters; the remainder were deposited locally in the main river channels.

These operations for the season of 1919 have been resumed on a larger scale. Although the work is still in progress, there is already a substantial increase over 1918, and the fall season may close with a record of 125,000,000 rescued food fishes. A summary to the end of September is here given:

| Headquarters. | Fish salvaged. | Headquarters. | Fish salvaged. |
|---|---|---|---|
| Friar Point, Miss | 680,583 | Meredosia, Ill | 2,349,404 |
| Canton and Clarksville, Mo | 1,033,391 | La Crosse, Wis | 23,229,430 |
| North McGregor, Iowa | 15,233,267 | Homer, Minn | 28.800.510 |
| Bellevue, Iowa | 24,882,420 | | |
| Cairo, Ill | 4,830,820 | Total | 101,039,825 |

The extent of this work may be better realized when it is stated that a score of hatcheries would be unable to produce fishes in number and size equal to those rescued. Nothing affecting the welfare of the fisheries of the Mississippi basin is of greater importance than the prevention of the losses that occur under natural conditions.

### Loss of a Pacific Salmon Hatchery.

Among other items in the deficiency bill as reported to the House of Representatives September 11, 1919, is one providing $50,000 for the reconstruction of the fish hatchery and other buildings at Baker Lake, Wash., which, with the exception of the bunk house and barn, were completely destroyed by fire on July 24, 1919. The disaster occurred at a most unfortunate time, as the season was but half over and the prospects for a large output were the brightest in years. Immediate steps were taken to prevent the failure of the work in progress, and as soon as the appropriation becomes available the reestablishment of the station in accordance with the most modern practice will be pushed to the utmost.

### Relations with the States in Fish-Cultural Work.

The fish-cultural operations of the bureau bring it into close relation with the various States, some of which are engaged in similar work, while others depend wholly on the Federal Government for the stocking of their waters with food fishes. In several States field stations are jointly operated by bureau and State employees, the eggs being incubated at the hatcheries most conveniently located or from which the resulting fish can be most advantageously distributed.

During the fiscal year 1919, upward of 670,000,000 eggs of fresh-water and anadromous fishes were donated to 24 States for hatching and distribution under their own auspices.

The shad hatchery at the mouth of the Susquehanna River, Md., has remained closed because of the continued failure of the State legislature to take action in harmony with the stipulations of Congress. The equipment of this station has been distributed among various other hatcheries.

### Biological Investigation of Fishes.

Many of the vital problems connected with fisheries and aquiculture require for their elucidation the application of scientific methods of investigation, and questions are constantly arising which require the services of trained biologists. The branch of the bureau that gives particular attention to these matters has during the past year conducted a number of investigations addressed to definite needs.

Among the fishes that have been the subject of special inquiry is the paddlefish of the Mississippi Valley, one of the important food fishes of our interior waters, now in danger of commercial extinction because of the intensity of the fishery conducted chiefly for its eggs, which are made into caviar. Up to the present time no efforts to hatch the paddlefish artificially have been successful, and there has also been lack of definite information regarding the natural spawning of the fish. In cooperation with the department of conservation of the State of Louisiana, there was undertaken during the past year a special study of the breeding habits of the paddlefish, and groundwork has been laid for further inquiry which it is hoped may save this valuable fish.

There have been instituted various investigations of the Pacific salmons. A special inquiry was directed to the very extensive practice of taking immature salmon by trolling and seining off the coasts of California, Oregon, and Washington. The conclusion was reached that any method of fishing which destroys immature salmon is so destructive and wasteful that it should be discontinued. The Department has communicated the results of the inquiry to the interested States and has indicated its readiness to assist them in determining the best means of meeting this menace to the salmon industry.

**Shellfish Investigations.**

Important scientific investigations have been devoted to oysters, mussels, and other shellfish. A study of great practical significance has been conducted in Long Island Sound, the scene of very extensive oyster-cultural operations, that have become seriously impaired by failure of the spat to set. In some sections more than half the grounds have ceased to be cultivated because of the small yield of oysters thereon, and for the past two years the set of spat has been entirely negligible. A temporary field laboratory has been maintained at Milford, Conn., and inquiries indicate that the wholesale death of spat in the shore waters may be attributable to pollution in the form of sewage and trade wastes. It has therefore been found desirable, in cooperation with the water laboratory of the Bureau of Chemistry, to make special studies of the nature and effects of the various pollutants.

Further investigations pertaining to the propagation, feeding, and growth of oysters have been conducted in Great South Bay, Long Island; Narragansett Bay, R. I.; Barnegat Bay, N. J.; all in cooperation with the State authorities. In extensive oyster beds in the York River, Va., a serious affection has for several years rendered the oysters unmarketable. The malady consists of a green discoloration associated with a watery and lean condition of the meat. No cause or remedy has yet been found, but the investigation is still in progress and will be continued until definite conclusions are possible.

The sea mussel continues to be one of the great unutilized aquatic resources of the north Atlantic coast. While the food value of this mollusk is well recognized, there has been curious delay in its general adoption into the dietary, even in the regions where it abounds and is best known. In continuance of its task of popularizing this valuable food article, the bureau has conducted a survey of the mussel beds of Maine, southern New England, and Long Island Sound, with a view to demonstrating the availability and abundance of mussels for use in a fresh condition and for preserving.

Between Portland and Eastport, Me., in six sections where the most important grounds are located, the survey showed upward of 1,200 acres of natural mussel beds, estimated to contain over 1,275,000 bushels. The best beds yield from 2,500 to 5,000 bushels to the acre. Leading packing houses on the north Atlantic coast are giving special attention to the canning of mussels, and there is reason to believe that the development of the mussel industry will not be long delayed and will add materially to the wealth and food supply of the country.

The practical operations in the artificial propagation of fresh-water pearly mussels, conducted at various points in the Mississippi Basin, resulted in the inoculation of 137,000,000 glochidia on suitable fish hosts. The output was less than in the previous year, owing chiefly to disturbed labor conditions. Investigations and experiments in the field of fresh-water mussels have continued to yield valuable results bearing on artificial propagation.

Among the crustacean shellfishes, the spiny lobsters of California and of Florida have been the subjects of studies addressed to their habits and growth. Upon the basis of the information furnished by the bureau to the State authorities of Florida, more effective protection has been provided by the legislature. Comprehensive reports on the life history of the blue crab and on the blue-crab fishery have been issued and are expected to be useful to State officials concerned with the protection of the crab and the maintenance of the fishery. It may be noted with gratification that an increased catch of blue crabs in Chesapeake Bay has recently been had; and it is conceded that this has been due to the adoption of wise measures of conservation based on the bureau's investigations and recommendations.

## Use of Fishes in Controlling Mosquitoes.

A novel and highly important extension of the scientific activities of the bureau has been the eradication of mosquitoes and the prevention of malaria in the vicinity of Army cantonments in cooperation with the Public Health Service. The duty devolving on the bureau in this cooperative work was the propagation of mosquito-eating fishes, their distribution in waters infested with mosquito larvæ, and the maintenance, in bodies of water that could not be drained, of conditions that promoted the effectiveness of small fishes in the control of mosquitoes. The most extensive operations were conducted in the vicinity of Camp Hancock and the city of Augusts, Ga., and the success there attained was so marked as to constitute a distinct advance in antimalarial work. The Surgeon General of the Public Health Service has expressed his appreciation of the assistance rendered, and has authorized the publication of a report setting forth the methods followed and the results achieved by the bureau in the extra-cantonment zone at Camp Hancock.

### Increased Utilization of Aquatic Products.

The Bureau of Fisheries has continued to render a large and important service to the fishing industry, the fish trade, and the public generally through its efforts to popularize neglected fishes and find uses and markets for wasted water resources. The work has consisted of practical demonstrations, technical investigations and appropriate publicity, and has been made possible chiefly by the allotment by the President of funds placed at his disposal for the national security and defense. Undertaken primarily during the war to increase the supplies of food and permit the exportation of meats to Europe, this campaign has, of course, equal value as a means of reducing living costs and of giving aquatic foods a larger permanent place in the national dietary.

Appeal has been made to Congress for adequate funds for carrying on this work, and meanwhile it has been necessary to greatly curtail all activities and to abandon some that were rendering important benefits to large numbers of people. Attention is asked to Appendix B, relating to this subject.

### New Sources of Aquatic Leather.

Material progress has been made in finding and utilizing new sources of leather from the skins of aquatic animals. The feasibility of producing commercial leather from such animals has been amply demonstrated, and the actual business has passed beyond the experimental stage, although work remains to be done in perfecting methods and in making generally known to the manufacturers of leather goods the availability and merits of the new products.

Many samples of aquatic leathers and of various articles made therefrom have been submitted to the bureau by private firms and have been favorably criticized by disinterested persons.

Among the manufactured objects made from fishskins that have come to the attention of the Department are traveling bags, brief cases, pocketbooks, belts, shoes, and ladies' hand bags. It is reported that the demand for shark leather for traveling bags is now greater than the supply, and plans on a very extensive scale are being executed for increasing and maintaining the output of shark hides by the establishment of special shark fisheries on the Atlantic, Pacific, and Gulf coasts. Excellent leather for shoes is also being derived from sharks.

The duty imposed on the Department by Congress in June, 1917, when there was made available the sum of $10,000 "for developing by the Bureau of Fisheries, in cooperation with the Bureau of Standards, new aquatic sources of supply of leather" may be regarded as having been accomplished, and private enterprise will now undoubtedly do what may be necessary to develop and give permanancy to the industry.

**Alaska Fisheries Service.**

The usual duties involved in the administration of the Alaskan fisheries have been performed. The corps of agents and wardens was supplemented by a stream-watchman patrol inaugurated in the season of 1918, consisting of 10 men engaged for the active fishing season. In addition to the enforcement of the laws and regulations governing fishing, the inspection of private salmon hatcheries and the taking of the census of red salmon entering Wood River, special investigations of a scientific and practical nature were made; work was done in opening up salmon streams for spawning; public hearings were held at Seattle concerning commercial fishery operations and conditions in the Copper and Yukon Rivers and all streams of southeastern Alaska; and detailed statistics of the fishery industry were compiled.

The returns for 1918 show a larger production than that of 1917, which far exceeded previous records. The number of persons employed in all branches of the industry was 31,213, an increase of 1,722 over 1917; the capital invested was $73,750,789, an increase of $18,813,240; and the value of products marketed was $59,154,859, an increase of $7,677,879. The increased value of products was chiefly owing to the larger pack of canned salmon in 1918 resulting from the strenuous effort to meet the food shortage. The canned-salmon industry surpassed all records, the pack reaching the grand total of 6,605,835 cases of forty-eight 1-pound cans, valued at $51,041,949. Of this, approximately three-eighths of the quantity and nearly one-half of the value represented red salmon. The salmon sold in a fresh, frozen, salted, and smoked condition brought the total value of the salmon to $53,514,812. Thus 50 years after the acquisition of Alaska, the salmon output alone was worth seven and one-half times the purchase price.

The Alaska fisheries service merits liberal appropriations from Congress. The corps available for enforcing the laws and regulations and for carrying out other obligations arising out of administrative responsibility is still inadequate. The vast extent of the salmon industry and the heavy drains that are being made on the supply necessitate an enlarged personnel for maintaining and extending the patrol, for making special investigations, and for conducting various lines of constructive work in the interest of the industry. Several large hatcheries should be established in regions of most extensive fisheries, such as Karluk and Nushagak.

The following is a summary of results of efforts of the Bureau of Fisheries to introduce the Scotch method of curing herring in Alaska during 1917 and 1918. The figures for 1919 are not yet available.

| | |
|---|---|
| Total cost of work, about | $12,000 |
| Pack, as follows: | |
| 1917, 7,622 barrels (1,905,000 pounds) | 114,330 |
| 1918, 38,977 barrels (9,744,250 pounds) | 748,606 |
| Total value | 862,936 |

**Alaska Fur-Seal Service.**

The calendar year 1918 was the first after the expiration of the law imposing a close time on the commercial killing of seals on the Pribilof Islands. The quota of skins that might be secured was fixed at 35,000 and the number actually taken was 34,883, all but 1,002 of which were procured by August 10, when operations have usually ceased because of the beginning of the stagy season.

For the season 1919 the quota was tentatively fixed at 35,000, and the number of skins actually secured to August 10 was 25,381. The conditions of the herd warranted the taking of a considerably larger number of skins, but the scarcity of experienced men, combined with the increased labor involved in removing and handling the skins of the larger seals, to which special attention was given, reduced the season's output. The epidemic of influenza which ravaged Alaska necessitated the establishment of a quarantine to protect the susceptible natives of the seal islands, and it became impossible to carry out the plans for obtaining additional labor.

In an effort to improve transportation facilities on the seal islands three tractors and a number of wagons for trailers have been sent this year. This equipment will not only be of the greatest value in transporting sealskins from the killing grounds to the salt houses, but will furnish the means of hauling carcasses from the killing grounds to the newly established by-products plant. The tractors will also be very useful in constructing roads.

With a special appropriation made by Congress, there has been purchased a power lighter for use at the Pribilof Islands and between the islands and Unalaska, the nearest commercial port, 250 miles distant. This vessel will be equipped with wireless apparatus, and a rapid-fire gun for use in any emergency that involves the protection of the seal herd.

Most of the supplies required for the Pribilof Islands and the products derived therefrom were transported on the steamer *Roosevelt*, which made three voyages between Seattle and the islands during the year. On the final voyage the vessel did not leave the islands until December 12, which appears to be the latest recorded date for any vessel in that part of Bering Sea. Certain supplies and products were carried by the Coast Guard cutter *Bear* and the naval radio tender *Saturn*. The lighthouse tender *Cedar* of this Department transported heavy pieces of machinery for the by-products plant.

The very trying service required of the steamer *Roosevelt* during the years actively engaged in the Alaska work, combined with the heavy duty that the vessel had performed in her memorable Arctic career, developed defects the repair of which would have necessitated a large outlay out of proportion to her total value. She was, therefore, sold at public auction in Seattle on July 15, 1919, for the sum of $28,000.

A very comprehensive account of the fur-seal service in 1918 is contained in a special report on Alaska fisheries and fur industries published by the Bureau of Fisheries. The native wards of the Government and their physical, mental, and financial condition are discussed at length.

There is need for an enlarged administrative personnel on the Pribilof Islands, including a superintendent and a biologist. With the acquisition of a vessel for interisland service, the islands need not hereafter be managed as distinct entities, but should be affiliated under one coordinating head. Vital scientific and technical problems are involved in the management of the rapidly increasing seal herd, and the creation of the position of biologist is demanded.

### Alaskan Seal Herd.

The fur seals resorting to the Pribilof Islands are continuing to increase under the beneficient protection afforded by the international agreement prohibiting pelagic sealing. The only untoward feature has been the accumulation of older male seals far beyond the requirements for breeding purposes during the 5-year close time. Fortunately, the bureau has found a means of utilizing to the pecuniary advantage of the Government the skins of surplus bulls, and the gradual elimination of disproportionate elements is proceeding.

The seal census of 1918 gave 496,611 animals of all ages as composing the herd on August 10, after the close of the regular killing season. The corresponding census for 1919, the results of which have been communicated by telegraph and are subject to slight revision, showed 524,260 seals in the herd as of August 10, in addition to the 26,383 seals that had been taken for their skins subsequent to the previous enumeration. The numerical strength of the herd increased about 11 per cent from 1918 to 1919. The detailed figures for 1919 are as follows: Breeding females, 157,172; new-born pups, 157,172; yearlings of both sexes, 92,891; 2-year-olds of both sexes, 66,352; males 3 years old, 13,576; males 4, 5, and 6 years old, 20,080; harem bulls, 5,158; idle and surplus bulls, 11,859; average harem, 30.47.

### Marketing Products of the Seal Islands.

During the fiscal year ended June 30, 1919, there were two sales of sealskins held October 7, 1918, and April 28, 1919. Fox skins were also sold at the October 7, 1918, sale.

The sealskins numbered 12,002, and were dressed, dyed, and machined before being offered for sale at public auction in St. Louis, Mo. The gross proceeds were $777,931; the expenses, including cost of preparation of skins, transportation, agents' commission, discount for cash, etc., aggregated $233,195.52; the net proceeds were thus $544,735.78.

The fox skins sold at public auction in St. Louis numbered 692 blue and 19 white pelts. The gross receipts were $58,179.50, the expenses were $6,280.86, and the net proceeds were $51,898.54.

On September 10, 1919, there were sold at St. Louis by Messrs. Funsten Bros. & Co., agents of the Department of Commerce, 9,055 dressed, dyed, and machined fur-seal skins and 665 blue and 30 white-fox skins. The total gross price realized was approximately $960,000. The sealskins averaged $91.35, an advance of 30 per cent over the prices realized last April. The blue foxes averaged $195.90, an advance of 135 per cent over prices realized last October, when the last sale of Government blue foxes occurred. The market was strong, bidding was spirited throughout, and there was a very large attendance of buyers. The results of this sale are highly gratifying.

A noteworthy development of the fur-seal industry during the year has been the demonstration of the high value of the skins of old male seals usually designated as "wigs" and the creation of an active demand for such skins. At the public auction sale in October, 1918, the best prices received for any sealskins were for "wigs," an experimental lot of which brought $75 each. At the sale in April, 1919, a considerable number of "wigs" were offered for sale in a dressed and dyed condition; these sold for $77 to $88 each, while the average price for all skins was $66. It should be noted that formerly "wigs" in the raw state were regarded as having little or no value in the London market.

The seal-island natives continue to collect old seal bones at times when they have no other work. They are encouraged to do this, and are paid for their labor. In 1919 about 300,000 pounds of bones were gathered, sacked, delivered on board Government vessels, and landed in Seattle and San Francisco. The net proceeds amounted to $3,891.03.

It is estimated that, when the entire take of sealskins for the calendar year 1918 shall have been dressed, dyed, machined, and sold, the net revenue to the Government, based upon the proceeds obtained at the sale of September 10, 1919, will be in excess of $2,450,000. To this should be added an approximate net revenue of $123,000 for the sale of fox skins. It is safe to say that, when the proceeds of the sales of bones, oil, and other by-products are taken into account, the net revenue for the products of the calendar year 1918 will reach a sum in excess of $2,600,000. This would more than pay all expenses of every nature connected with the administration of the Pribilof Islands, the Alaskan salmon fisheries, and the care of the minor fur-bearing animals of Alaska for a period of 12 years.

The accumulated experience of the Department under the contract with Funsten Bros. & Co., of St. Louis, Mo., for dressing, dyeing, machining, and selling fur-seal skins and for selling fox skins from the Pribilof Islands has proved very beneficial to the Government. The contractors have rendered highly satisfactory service in every feature. They have not only scrupulously observed every expressed and implied obligation of their contract, but they have willingly assumed other responsibilities and duties which, while meaning nothing to them in a pecuniary way, have meant much to the Government. The service rendered has been of a high order; the quality of the finished products has been superior to the best obtainable elsewhere; the methods of conducting the public auction sales have deserved and received the approbation of the entire fur trade; and the financial interests of the Government have been constantly safeguarded. The Government-owned furs have been in active demand and have brought the highest prices in the history of the fur business.

As a result of the profit to the Government under the contract, the latter has been extended so as to expire on December 15, 1926.

### Minor Fur-Bearing Animals of Alaska.

The minor fur-bearing animals of Alaska have received the usual attention, with assistance from special wardens whose services have been available through a reciprocal arrangement with the Governor of Alaska. There have been a number of prosecutions for violations of the regulations, and seizures of furs have been made from time to time. The furs thus confiscated have been sold at public auction and the proceeds covered into the Treasury of the United States.

There have been two modifications of the regulations: The use of dogs for pursuing and killing fur-bearing animals for which close seasons exist has been prohibited, and the open season on foxes in the region drained by streams flowing into the Arctic Ocean north of the sixty-eighth parallel of north latitude has been extended 30 days, or until April 15. Fur-farming operations have been continued at a number of places along the coast and in the Yukon region, and some successful results have been reported.

Through the cooperation of postmasters, collectors of customs, shippers, and others, the usual compilations of statistics of furs shipped from Alaska have been made possible. The value of furs for the year ending November 15, 1918, was $1,363,330, as compared with $1,064,249 for the previous year, due largely to the advance in the price of furs. With the exception of lynx, there was also an increase in the number of pelts of the more important species of fur-bearing animals shipped from Alaska. The more notable increases were of ermine, foxes, mink, muskrat, land otter, wolves, and wolverines.

**Fishery Legislation Needed.**

The most urgent requirement in connection with the fisheries of Alaska is for a new code covering the salmon fisheries to replace the existing obsolete and inadequate laws. Proper administration, efficient regulation, rational conservation, and fair revenue to the Government can not be secured unless the salmon laws are revised to meet present conditions. Legislation is desired also to lodge the administration of the minor fur-bearing animals of Alaska elsewhere than in the Bureau of Fisheries, an agency whose legitimate functions are entirely irrelevant to land mammals.

There is urgent need also for amendment of the law of June 14, 1906, prohibiting aliens from engaging in the fisheries of Alaska. The defects in the present law result in the violation of the spirit of the law and permit the actual exploitation of the fishery resources of Alaska by alien fishermen operating independently and having no regard for laws or regulations designed to perpetuate the industry.

The prevention of waste in the Alaskan halibut fishery and protection to the halibut grounds should be promptly brought about by legislation in accordance with the recommendation of the American-Canadian Fisheries Conference. Legislation to be effective should be uniform in the United States and Canada.

## BUREAU OF LIGHTHOUSES.

(GEORGE R. PUTNAM, *Commissioner.*)

### Cooperation with Navy and War Departments.

The lighthouse vessels and stations operated under the jurisdiction of the Navy Department during the war were returned to the Lighthouse Service July 1, 1919.

The Lighthouse Service, in addition to the work done by the tenders directly under the orders of the War and Navy Departments, during the war provided facilities at various depots for the berthing of naval vessels, and at the general lighthouse depot at Tompkinsville, N. Y., provided special coaling facilities and quarters for naval detachments. Additional buoys were placed, and other changes in aids to navigation were made, as required. Repairs to naval patrol boats were made at various points, and various buoys, moorings, and other appurtenances were transferred to or purchased for the Navy and War Departments. The Lighthouse Service also cooperated with the Navy Department and Treasury Department in connection with improvements in coast-communication facilities by telephone and radio and in the transmission of reports received from light stations and considered of possible military value.

Because the tenders of the Lighthouse Service are particularly well equipped for handling buoys, moorings, etc., and their officers are thoroughly familiar with the coast line and waters of the United States, these vessels were effectively used by the War Department in mine-planting operations and by the Navy Department in laying submarine-defense nets, etc., during the war and later in removing these defenses.

### Aids to Navigation.

In addition to this cooperation with the military service, the regular work of the Service in maintaining and improving aids to navigation was actively carried on during the year. During the fiscal year three important light and fog-signal stations were established from special appropriations—namely, at Lorain Harbor, Ohio, at the end of the west breakwater, to mark the entrance to the harbor; at Sand Hills, Mich., to mark a dangerous locality on the south shore of Lake Superior; and at Lime Kiln, San Juan Island, Wash., to mark an important point on the route from Puget Sound to British Columbia and Alaska.

Three unwatched acetylene lights were established in the Caribbean Sea to mark the traffic lane between the Gulf coast of the United States and the Panama Canal through Yucatan Passage. This important maritime track lies between low coral reefs and islands in the northwestern part of the Caribbean Sea. The work was done in cooperation with the Navy Department, which furnished a gunboat to transport the working party and materials.

An unwatched acetylene light was established at Dog Island, Me.

During the year 36 new aids were established in Alaska, including 19 light stations, 1 gas and bell buoy, and 16 other aids. The total number of aids to navigation in Alaska at the end of the fiscal year was 475, being a net increase of 36 over that of the preceding fiscal year, and the total number of lights was 180. The appropriation by the sundry civil act approved July 19, 1919, of $75,000 for aids to navigation in Alaska has permitted active steps toward further safeguarding those dangerous waters.

The work to be done was already listed, ready, when the money became available and instructions to proceed were given by telegraph in order to accomplish as much as possible during the present season.

A total of 736 new aids to navigation were established during the year, including 178 fixed lights, 6 float lights, 1 light vessel, 73 gas buoys, and 469 other aids, the total number in commission on June 30, 1919, being 16,075, a net increase of 400 over the preceding fiscal year.

Considerable work was done during the fiscal year in repairing damage to aids to navigation caused by ice floes during the winter of 1917–18, especially to screw-pile structures in Chesapeake Bay and Potomac River. Much was also done in repairing hurricane damage to aids in the Gulf of Mexico, reconstructing stations, so far as practicable, in a manner calculated to better withstand future destruction.

Various special works were actively in progress during the year, including the establishment of important new light and fog-signal stations and lighthouse depots, improvements in systems of fixed aids and buoyage, etc.

Improvement in illuminating and fog-signal apparatus of existing aids was continued. Fixed lights were replaced by flashing or occulting lights at 20 stations, including two light vessels; incandescent oil-vapor lights were substituted for oil-wick lamps at 4 stations; and acetylene or electric incandescent illuminant was substituted at 36 stations, including 5 light vessels and 2 buoys The fog-signal apparatus at 7 important stations was improved by the substitution of air diaphones for less efficient apparatus.

General repairs required to maintain aids to navigation in efficient condition were continued, but insufficiency of funds prevented this work being done to the proper extent.

Damage to lighthouse property, estimated at $13,500, was sustained on December 8, 1918, by a fire at Execution Rocks Light Station, N. Y. The fog-signal engine and machinery, also the tower, oil house, and dwelling, were damaged.

On March 11, 1919, a gas buoy burst while being tested at a lighthouse depot by means of hydrostatic pressure, injuring two employees, one of whom died later as a result of injuries received. The accident was carefully investigated and steps taken to insure the observance of precautions.

An earthquake and tidal wave of considerable intensity occurred in Porto Rico and vicinity on October 11, 1918. Lighthouse property was not seriously damaged, except at Point Borinquen and Point Jiguero Light Stations.

The mild winter of 1918–19 presented a great contrast to the severe weather of the preceding winter, and permitted the removal of buoys from their stations for the winter without loss or trouble, and in some cases buoys usually removed for the winter were kept on station throughout the year. This rarely happens in north Atlantic waters.

**Vessels.**

There is a very urgent need for the construction of additional vessels for the Lighthouse Service, to replace those worn out in service, those lost through various casualties, and to meet the considerable growth of the Service in recent years. A full statement of this situation is given in Appendix A to this report.

Relief Light Vessel No. 51, stationed on Cornfield Point light vessel station, Conn., was collided with and sunk by a barge barge in tow of a Standard Oil tug on April 24, 1919. The light ship went down in eight minutes after being struck. Good judgment and discipline on the light vessel were shown in the emergency. No injury was sustained by the crew. The lifeboat and log and fog-signal books were the only property of the light vessel saved. This vessel was of iron, built in 1892. The owner of the tow has been called upon to indemnify the Government.

Bush Bluff Light Vessel No. 97, was surveyed and condemned for sale, being in such a poor condition as not to warrant repairs. Bush Bluff Station is now marked by a gas and bell buoy, the bell being operated by carbonic-acid gas, a test installation of this apparatus.

The tender *Cedar* performed urgent special duty in connection with the influenza epidemic last fall. Physicians and nurses in charge of a medical officer of the United States Public Health Service were carried to isolated localities in southeastern Alaska, principally native Indian villages.

### Lighthouse Depots.

Construction of the lighthouse depot for the sixteenth district, at Ketchikan, Alaska, for which an appropriation of $90,000 was made by act of July 1, 1918, was actively carried on during the year. On June 30, 1919, the wharf was about 95 per cent completed, and the entire work, including storehouse, shops, etc., about 35 per cent completed.

Important improvements are in progress at the general lighthouse depot, Tompkinsville, N. Y. The act of March 28, 1918, appropriated $60,000 for repairs to the wharves. This work includes the removal of the old wooden wharf decks and construction of concrete decks with cast-iron pile columns and other improved features. In order to permit use of the wharves while improvements are in progress, the work is being done in three sections. The first section, the south wharf, was completed in February, 1919. It is expected that the second section will be completed about September, 1919.

In August, 1918, you allotted from your fund for national security and defense $175,000 for improvement of coaling facilities at this depot, with particular reference to cooperation work with the Navy. This work is in progress, and it is expected will be completed about February, 1920.

The act of July 19, 1919, appropriated $30,000 for extending and enlarging the machine shop at this depot, and plans are being prepared.

The act of June 12, 1917, appropriated $21,000 for improving the office and laboratory at this depot. This work has been completed, except the installation of a heating system and other work of minor importance.

The act of July 1, 1918, appropriated $85,000 for the construction of a depot for the second lighthouse district. A portion of the old marine-hospital property in Chelsea has been transferred as a site for this depot. The work is in progress, but the amount available is quite insufficient for the complete construction.

The act of June 20, 1918, authorized $275,000 for improvements at the lighthouse depot at Portsmouth, Va., or establishing a new depot, but no appropriation has been made for this work. This is the principal depot of one of the largest lighthouse districts and is the headquarters for five tenders and two light vessels. The facilities for berthing these vessels is entirely inadequate, and the efficient operation of the vessels is much hampered in consequence. The inadequacy of space for storing and handling buoys also causes delay and loss.

A new depot for the seventh lighthouse district, at Key West, Fla., is urgently needed for the efficient and economical handling of the work of the district. The present depot is located on property belonging to the Treasury Department, with naval coal sheds and piers on either side. The space allotted the Lighthouse Service for buoys and appendages is entirely inadequate. The depot consists of a wooden storehouse built on a wooden pier. There is no oil house at this depot, due to lack of space, and kerosene, gasoline, and other inflammable supplies have to be kept in the storehouse, constituting a constant menace of fire.

Suitable depot facilities at Honolulu for the nineteenth lighthouse district are also much needed, and an estimate has been submitted for this purpose.

### Improvement of Apparatus and Equipment.

Radio equipment was installed on 28 light vessels and on 12 tenders during the fiscal year. At the end of the fiscal year 41 light vessels and 23 tenders had been equipped with radio installations.

The installation of telephones at light stations was continued during the year. This work was done by the United States Coast Guard under an appropriation to develop coastal communications, including connections with important light stations. On June 30, 1919, there were 139 light stations so connected.

Experiments and tests with various devices and equipment used in lighthouse work have resulted in developing improvements in the interests of efficiency and economy. Among these may be mentioned improvements in diaphone installations, resulting in simplicity of operation, reduced space required for machinery, and lowered initial cost. A new type of metal buoy was developed for use in defining shoal-water channels, being an improvement over wooden spar buoys, which are less conspicuous and more expensive to maintain. The stability of the type L gas and bell buoy moored in the exposed waters of Alaska was improved.

On account of immunity from submarine boring insects the use of palmetto piles has been extended in southern waters.

An improved device for fastening moorings to buoys in the upper Mississippi River was tested and proved satisfactory.

Investigation of the use of radio for fog-signal purposes was interrupted by war activities, but is now resumed.

### Personnel.

On June 30, 1919, there were 5,964 persons employed in the Lighthouse Service, including 125 technical, 156 clerical, and 5,683 employees connected with light stations, vessels, and depots. This Service is charged with the maintenance of aids to navigation along 47,300 statute miles of coast line and river channel.

The retirement system for the field service of the Lighthouse Service was put in effect upon the appropriation by Congress of the necessary funds by act approved November 4, 1918. By the same act the retirement law was amended to the extent that the provisions of the law do not apply to persons in the field service whose duties do not require substantially all their time. The effect of the retirement system has been very advantageous, both to the Service and the personnel, and at a moderate expense.

### Saving of Life and Property.

During the fiscal year services in saving life and property were rendered and acts of heroism performed by employees of the Lighthouse Service on 111 occasions. Many of these acts were considered especially meritorious, and the employees were individually commended by me.

### Administration.

The system of cost keeping for the Service was modified, reducing the amount of detail work required in district offices without sacrificing the essential data furnished. This modification was necessary in order that other important work might be kept up.

The Department approved regulations for the distribution of lighthouse publications on a sales basis, pursuant to act of Congress of June 20, 1918. This was put in effect January 1, 1919. Sales agencies have been established at the principal ports. Returns of sales are made to the Superintendent of Documents, Washington, D. C., who supplies the necessary copies of the publication.

The appropriations for the maintenance of the Lighthouse Service for the fiscal year 1920 are $6,625,000, being $474,570 in excess of those for the preceding fiscal year, and include $45,000 for retired pay. In addition, there are special appropriations aggregating $794,400, including $440,000 contained in the deficiency act of November 4, 1918.

The appropriations for the maintenance of the Lighthouse Service for the fiscal year 1920 were $1,054,600 less than the estimates submitted, and additional funds will be necessary for even the minimum maintenance of the Service during this fiscal year.

During the last fiscal year $774,000 was transferred from Navy Department appropriations to make good deficiencies in the maintenance of the Lighthouse Service, but as the vessels and stations were transferred back on July 1, 1919, funds will not be available from the similar provisions in the naval appropriation act this year.

Systematic inspections have been continued in the various lighthouse districts of the technical work, business methods, and property accounts.

### Special Legislation Needed.

The act of August 29, 1916, authorizing the President to transfer to the Navy or War Department portions of the Lighthouse Service when there is a national emergency, should be amended so as to definitely define the status of the personnel transferred. All persons so transferred who serve on vessels or at stations where they are exposed to the risks of war, should have a suitable military status, and be entitled to all relief provided by legislation for those in the military services. Although the personnel transferred during this year were, under rulings of the Treasury Department, given the benefits of the war-risk insurance, there was considerable conflict in decisions as to their standing under the act of August 29, 1916. All of the personnel were in an indefinite and anomalous position in their relations with the military and naval personnel. Specific recommendation is deferred until conditions become more settled. In any future transfer of vessels there should, if practicable, be more definite understanding as to the extent to which tenders are to be diverted from their lighthouse duty. The upkeep of the system of aids to navigation requires every effort of the present equipment of tenders, and their efficient maintenance is even more important in time of war than in normal times.

Legislation is recommended to cover adjustment of claims by lighthouse employees for loss or damage to personal property, such as clothing, furniture, etc., caused by storm, tidal waves, collisions, or fire at light stations, depots, and on vessels. Such provision should be made in justice to these employees engaged on hazardous duty. By act of June 17, 1910, it was provided that claims against the Government for damages not exceeding $500 arising out of collisions for which lighthouse vessels are responsible be determined and settled by the Commissioner of Lighthouses. This provision has enabled the Government to adjust claims promptly and has relieved Congress of the annoyance of many petty claims; and similar legislation covering losses of personal property by lighthouse employees would be advantageous to the Government and result in more equal justice to employees.

Legislation is also recommended providing for medical relief for lighthouse keepers without charge at other than hospitals and stations of the Public Health Service. The hospitals and stations of the Public Health Service, at which free treatment is now provided for lighthouse keepers, are obviously inaccessible for a large number of keepers.

Legislation is recommended authorizing the establishment and maintenance of post-lantern lights and other aids to navigation on the Yukon River and its tributaries, Alaska. The waters of the Yukon delta are already being marked, but congressional authority is required for the Lighthouse Service to extend its jurisdiction to the nontidal waters of these rivers. Navigation of the Yukon River is increasing, and as it is navigable for a long distance many lights and day marks are required.

An appropriation of $50,000 is strongly recommended for establishing and improving aids to navigation in the Virgin Islands of the United States, West Indies, and adjacent waters. This work was authorized by Congress by the act approved June 20, 1918 (40 Stat., 608), but no appropriation has been made. The Naval Governor of the Virgin Islands in a letter dated July 15, 1919, strongly urged that this matter be given the serious consideration it deserves in order to facilitate and safeguard the very large amount of shipping in these islands.

The act of June 20, 1918, providing for voluntary retirement at the age of 65 after 30 years' service, and compulsory retirement at the age of 70, for certain classes of employees of the Lighthouse Service has proved beneficial both to the men eligible to retirement and to the Service in replacing such men with younger and more capable employees. Still greater efficiency, however, will result and hardship to deserving employees will be avoided if the same benefits are extended to persons who become disabled from efficiently performing their duties by reason of disability incident to their work, such disability being distinct from that caused by injury received in the line of duty, for which compensation is now provided by law. Legislation to this end is recommended.

**Appropriations for Special Works.**

The sundry civil act approved July 19, 1919, made the following appropriations for special works in the Lighthouse Service:

| | |
|---|---|
| Restoring and improving Execution Rocks Light Station, N. Y. | $10,000 |
| Rebuilding Point Jiguero Light Station, P. R. | 24,000 |
| Improving the light and fog signal at Manitowoc Breakwater Light Station, Wis. | 9,000 |
| Completing the removal and rebuilding of Chicago Harbor Light Station, Ill., and establishing lights on the new breakwater in Chicago Harbor | 6,400 |
| Constructing light keepers' dwellings and appurtenant structures, including sites therefor, within the limit of cost fixed by the act approved February 26, 1907 | 50,000 |
| Extending and enlarging the machine shop at the lighthouse depot, Tompkinsville, Staten Island, N. Y. | 30,000 |
| Providing riprap to reinforce foundations of light stations and constructing or improving boat landings in the third lighthouse district | 150,000 |
| Establishing new aids to navigation and improving existing aids in Alaska | 75,000 |

Measures were taken to inaugurate work on all these projects and to push them to completion as promptly as possible.

The deficiency appropriation act now pending contains the following items for the Lighthouse Service:

| | |
|---|---|
| Constructing or purchasing and equipping tenders and light vessels to replace those worn out in service | $760,000 |
| Diamond Shoal Light Vessel, N. C. | 450,000 |
| Completing the light and fog-signal station at Conneaut, Ohio | 19,600 |

The item of $760,000 is of special importance, marking the beginning, and only the beginning, of the process of replacement of the many old and worn-out vessels in the Service, referred to in Appendix A of this report. The item of $450,000 for Diamond Shoal is for the replacement of the light vessel sunk by a German submarine on August 6, 1918.

## COAST AND GEODETIC SURVEY.

(Col. E. Lester Jones, *Superintendent.*)

**Important Publications.**

Two publications of special importance were issued during the fiscal year 1918.

One of these is the series of publications on the Lambert Conformal Conic Projection. The principle of the Lambert projection is in a measure graphically illustrated in the figure opposite.

Many methods of projection have been designed to solve the difficult problem of representing a spherical surface on a plane. As different projections have unquestionably merits as well as equally serious defects, any region to be mapped should be made the subject of special study and that system of projection adopted which will give the best results for the area and purposes under consideration.

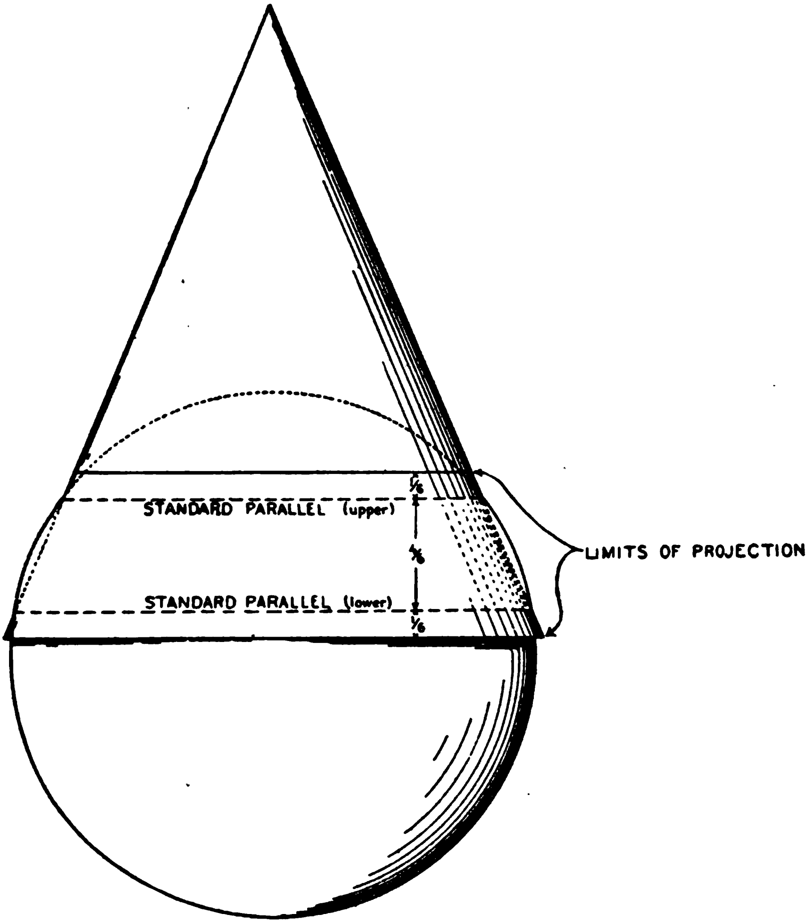
The Mercator projection, almost universally used for nautical charts, is responsible for many false impressions of the relative size of countries differing in latitude. The polyconic projection widely used and well adapted for most topographic and hydrographic surveys, when used for the whole of the United States in one map, has the serious defect of unduly exaggerating the areas on its eastern and western limits. Along the Pacific coast and in Maine the error in scale is as much as 6½ per cent, while at New York it reaches 4¼ per cent.

The value of the new outline map on the new Lambert projection can best be realized when it is stated that throughout the larger and most important parts of the United States—that is, between latitudes 30½ and 49°—the maximum scale error is only one-half of 1 per cent. This scale error of one-half of 1 per cent is frequently less than the distortion due to the method of printing and to changes from the humidity of the air. Only in southernmost Florida and Texas does this projection attain its maximum error of 2⅓ per cent.

The Lambert projection is well adapted to large areas of predominating east-and-west dimensions, as the United States, where the distances across from east to west is one and four-fifths times that of the distance north and south.

The strength of the polyconic projection, on the other hand, is along its central meridian. The merits and defects of the two systems of projection may be stated in a general way as being at right angles with each other.

Special features of the Lambert projection that are not found in the polyconic may be stated briefly, as follows:



LAMBERT'S CONFORMAL CONIC PROJECTION
Diagram illustrating the intersection of a cone and sphere along the two standard parallels.

1. The Lambert projection is conformal; that is, all angles between intersecting lines or curves are preserved, and for any given point (or restricted locality) the ratio of the length of a linear element on the earth's surface to the length on the corresponding map element is constant for all azimuths or directions in which the element may be taken.

2. The meridians are straight lines and the parallels are concentric circles.

3. It has two axes of strength instead of one, the standard parallels of the map of the United States being latitudes 33° and 45°, and upon these parallels the scale is absolutely true. The scale for any other part of the map, or any parallel, can be obtained from tables contained in one of the series of these publications. By means of these tables, the very small scale errors in this projection can be entirely eliminated.

The other publication is the Report on the Connection of the Arcs of Primary Triangulation Along the Ninety-Eighth Meridian in the United States and in Mexico and on Triangulation in Southern Texas.

An event of the greatest importance in the history of geodesy was consummated in the spring of 1916, when observations were made at stations on the northern and southern banks of the Rio Grande, which connected the arcs of primary triangulation which had been established in the United States and in Mexico along the ninety-eighth meridian. The connection is interesting to the geodesist, because it makes available a very long meridional arc of connected and completed triangulation.

This connection will make available data from which to compute with greater accuracy than heretofore the dimensions of the earth. This will in itself make the work a notable contribution to science. But of even greater moment is the fact that the connection of the triangulation of the United States and Mexico will enable the latter country to extend to new areas from the ninety-eighth meridian arc geodetic control for surveys and maps in the form of triangulation which can be made on the North American datum.

This datum had been called the United States standard datum previous to the year 1913, when it was also adopted by Mexico and Canada for their geodetic coordinates. Its designation was changed to the North American datum when it had thus attained an international character.

**Field Work.**

This country was at war with Germany during the period this report covers, and the naval needs of the country required all available vessels. It was, therefore, very late in the fiscal year 1919 before any vessels could be released for civil duties. The five vessels of the Coast and Geodetic Survey that had been transferred to the Navy Department to meet its needs were retransferred to the Coast and Geodetic Survey April 1, 1919, by Executive order. These vessels are the *Surveyor*, the *Bache*, the *Isis*, the *Explorer*, and the *Patterson* (temporarily renamed the *Forward*). Under authority of the act of Congress, section 8557, Compiled Statutes (R. S. 4686), the President is authorized to transfer such vessels, boats, and auxiliary ships or any of them which are not necessary to the needs of the Navy to any other executive department of the Government that has need for such vessels. Acting under this authority, the following vessels of the Navy Department were transferred to the service and jurisdiction of the Coast and Geodetic Survey: *Natoma*, April 9, 1919; *Wenonah*, April 12, 1919; *Onward*, April 19, 1919; *Ranger*, April 28, 1919; *Arcturus*, May 5, 1919.

The following table gives a condensed statement of the vessels at the disposal of the Coast and Geodetic Survey within the fiscal year:

| Name of vessel. | Transferred to Coast and Geodetic Survey by Navy. | Loaned to Coast and Geodetic Survey by Philippine Government. | Owned by Coast and Geodetic Survey at beginning of fiscal year. | Sold during the fiscal year. |
|---|---|---|---|---|
| Arcturus | 1 | | | |
| Bache | | | 1 | |
| Cosmos | | | 1 | |
| Explorer | | | 1 | |
| Fathomer | | 1 | | |
| Hydrographer | | | 1 | |
| Isis | | | 1 | |
| Matchless | | | 1 | 1 |
| Natoma | 1 | | | |
| Onward | 1 | | | |
| Pathfinder | | | 1 | |
| Ranger | 1 | | | |
| Patterson | | | 1 | |
| Romblon | | 1 | | |
| Surveyor | | | 1 | |
| Wenonah | 1 | | | |
| Total | 5 | 2 | 9 | 1 |

| | |
|---|---|
| Transferred from Navy | 5 |
| Loaned by Philippine Government | 2 |
| Owned by Coast and Geodetic Survey | 9 |
| Total | 16 |
| Sold during the year | 1 |
| Total vessels at disposal of the Survey at end of fiscal year | 15 |

The following statement is instructive as to the size of the vessels now operated by the bureau:

| | Gross tonnage. | | Gross tonnage. |
|---|---|---|---|
| Surveyor | 1,000 | Explorer | 335 |
| Pathfinder | 690 | Wenonah | 240 |
| Patterson | 500 | Ranger | 219 |
| Arcturus | 456 | Onward | 157 |
| Fathomer | 431 | Matchless | 118 |
| Romblon | 411 | Hydrographer | 116 |
| Isis | 377 | Natoma | 112 |
| Bache | 370 | | |

Summarized, the hydrographic accomplishments during the fiscal year are as follows:

| | Square statute miles. |
|---|---|
| Ship hydrography | 784.2 |
| Launch hydrography | 89.1 |
| Wire-drag surveys | 510.6 |
| Revision surveys | 82.0 |

Last year Congress authorized a nominal extra compensation to employees of the Bureau of Lighthouses stationed on lightships when they are engaged in making current observations for the Coast and Geodetic Survey. Under this arrangement observations were begun as soon as instruments could be procured and installed on the various lightships. Within the year such observations were made on 23 different lightships stationed on both the Atlantic and Pacific coasts.

Short series of current observations were made at 57 different stations on both the Atlantic and Pacific coasts.

Tidal observations were made throughout the year at 12 permanent tidal stations, 9 on the Atlantic and Gulf coasts, and 2 on the Pacific coast. Besides the tidal observations at the permanent stations, important observations were made at 44 different stations on both coasts of continental United States, and on the coasts of Alaska and the Philippine Islands. In connection with the hydrographic work, 96.7 square miles of topography were executed.

Primary triangulation was executed from the ninety-eighth meridian, in the vicinity of Waco, Tex., to Robeline, La. The length of this scheme is 255 miles, and an area of 3,570 square miles was covered. Secondary triangulation was run from Sanford, N. C., to the vicinity of Madison, N. C. The length of the scheme is 120 miles, and the area covered is 1,700 square miles. Secondary triangulation was also run from Turkey Point Light to Sandy Point Light, Chesapeake Bay. The length of this scheme is 37 miles, and the area covered is 210 square miles.

Tertiary triangulation was executed as follows: Morro Bay, Calif.: Length of scheme, 5 miles; area covered, 8 square miles. Key Biscayne in the vicinity of Miami, Fla.: Length of scheme, 15 miles; area covered, 42 square miles. Vicinity of Charleston S. C.: Length of scheme, 14 miles; area covered, 27 square miles

A primary traverse was run from Vaughan, N. C., to Blaney, S. C. The length of the line is 235 miles. Another primary traverse was run from Wilmington to Sanford, N. C. The length of this line is 125 miles.

One arc of reconnoissance extends from the vicinity of Waco, Tex., eastward to Robeline, La. The length of this reconnoissance is 255 miles. Another reconnoissance, 50 miles in length, was run in the vicinity of Prescott, Ariz. A line of reconnoissance, also 50 miles in length, was run in the vicinity of Richfield, Utah.

There were 1,190 miles of precise leveling run during the fiscal year 1919. Magnetic observations were made during the year at 77 stations in 11 States, of which 34 were new primary stations, 17 auxiliary stations, 22 repeat stations for the determination of secular change, and 4 new stations in old localities. The regular observatories of the bureau at Cheltenham, Md.; Vieques, P. R.; Tucson, Ariz.; Sitka, Alaska; and near Honolulu, Hawaii, were in operation throughout the year.

### Needs of the Survey to Better Accomplish its Field Work.

The end of the fiscal year finds the Survey with a fleet of 15 vessels, a truly considerable number when compared with those available in previous years and probably more than has ever been at the disposal of the bureau at any one time in its history. This comparatively large number of vessels is due to the fact that five vessels have been transferred to the bureau from the Navy Department under authority of the Executive order of May 24, 1919. These five were part of a number of vessels that the Navy Department had acquired to meet the temporary naval need for patrol boats, etc., during the war. Even with these additions from the Navy Department, however, the condition of the Survey's fleet is unsatisfactory. While there are numbers, there are inefficient units. When it was learned that the Navy had vessels that could be transferred, a board of Coast Survey officers was appointed to consult with the proper officials of the Navy Department to learn what vessels were available for transfer that were suited to the needs of the Survey. After a thorough examination of all the vessels that the Navy Department had available for transfer, the board recommended that the five vessels above named be taken over. These vessels were accepted not because they are wholly suited for our work, but because they are the best means to an end at the present time. I feel that we have a great responsibility in meeting the marine needs of this country in finding and charting the dangers to navigation. The need is so pressing that we are confident that we are justified in doing what can be done with these vessels turned over by the Navy Department, though at an overhead cost considerably more than if vessels designed for the use of the Survey could be had.

The vessels we have thus acquired, after a careful investigation of those available, can not be efficiently operated as surveying vessels. Ship hydrography can not be economically carried on with a vessel that is too large, because too large a complement of officers and men is required, nor can the work be done with safety with a vessel that is too small, because she can not live through the severe weather that will be met. Furthermore, the character of the area to be surveyed seldom permits clean-cut classification, so that it can be determined before hand that this portion of it will be done by vessel and that by launches. Greater and more economical progress is made if the vessel is equipped to carry launches on her deck, and when the field of operation is reached the launch hydrography (in waters too shallow for the vessel to operate) is done in conjunction with the ship hydrography. Thus the entire area is covered by the same party during the same season.

There are two classes of ship hydrography: Offshore, such as that off the coasts of California, Oregon, and Washington, out to the 1,000-fathom curve. The other class is known as combined hydrography, such as that along the coast of Alaska, where there are many areas of which the deeper water hydrography must be done by a vessel and the waters inshore by launches.

The particular reasons why the yachts that we have obtained from the Navy Department are not suitable for either of these classes of hydrography are these: The offshore hydrography that must be done by ships along the coast of Washington, Oregon, and California out to the 1,000-fathom curve extends a general average distance of 30 miles from shore. Along these coasts the harbors of refuge are few and far between. Furthermore, the storms encountered within the area that must be surveyed are generally very severe. To buffet the storms that will surely be encountered a stanch sea-going vessel is required. The yachts now in our possession have neither the strength required of hull nor machinery to stand the strain to which they would be subjected in these storms. Furthermore, if they were stanch enough for this outside work, they have not the fuel capacity to make it economical to operate them there. Too much time would have to be expended in running to the widely separated ports to obtain fuel supplies. This class of hydrography is done by running lines of soundings at right angles to the shore to and from the shore out to the 1,000-fathom curve. If a vessel only has fuel capacity to enable her to make but a few trips from the shore out to the 1,000-fathom curve and back to shore and then she must abandon her work and steam some hundreds of miles to a port to obtain a fresh supply of fuel, it is readily seen that there is an enormous loss of time, and consequently a great overhead cost to carry on this class of surveys with such a vessel. Vessels properly designed for this work are oil-burning and have a cruising radius of several thousand miles.

The other class, known as combined hydrography, covers areas where for the sake of economy the ship hydrography and the launch hydrography should be executed at the same time. The vessels that came to us from the Navy Department were yachts. They were built for speed and along narrow lines. They neither have the deck room for the storage of launches or for installation of hoisting apparatus for hoisting them aboard the vessel, nor the stability to carry the apparatus.

It seems to be the impression that there is no justification in our asking for appropriations for new vessels especially designed for the work of this bureau so long as there would be surplus vessels after the war; but such views are erroneous. A great public need would be more quickly met, and in the long run dollars that come from the Public Treasury would be saved if proper surveying vessels were provided for this bureau. It costs practically as much in personnel, food, fuel, and supplies to operate an inefficient vessel as it does to operate an efficient one. As it is, we will make what progress we can at a very considerable loss of efficiency in picking here and there sheltered waters where these vessels can be used, and equip the larger ones with as many launches as they will carry, probably not more than two, so that the vessel hydrography will progress more rapidly than the launch hydrography and delays will be enforced in regions where combined vessel and launch hydrography are necessary. There is as much necessity for vessels of special design for making surveys as there is for use as tugs, ferries, lightships, and for freight or passenger vessels.

In 16 years, or from 1903 to 1919, but one effective appropriation was made for vessels for the Coast and Geodetic Survey, and that was for the fiscal year ended June 30, 1916, when the sum of $289,000 was authorized for two new vessels, including their equipment. Through this appropriation we procured two vessels, one especially designed and built for a surveying vessel, and the other was purchased. For the fiscal year ended June 30, 1919, an appropriation was made in the following words: "For one new vessel, including equipment, to cost not exceeding $354,000, $50,000."

The question was submitted to the Comptroller of the Treasury whether there was authority to enter into a contract for the construction of a vessel to cost not exceeding the limit mentioned. The Comptroller held that the legislation did not in specific terms declare that a contract could be executed in excess of the amount appropriated, and therefore such a contract would be in violation of the act of June 30, 1906.

We have never had the vessels and personnel to bring the surveys of our waters up to a proper standard. The charts of Alaskan waters are incomplete, and the information shown on many of them is from exploration surveys by the Russians before Alaska was acquired by the United States and with a lack of exactness that would not be tolerated at the present time. The charts of the waters of the three Pacific Coast States do not contain sufficient information for offshore navigation and many of the charts of the Atlantic coast and Gulf coast of the United States are lacking in the same respect. And this should be borne in mind, that heretofore the vessels that plied our waters have been largely of foreign registration, and, therefore, losses on account of inadequate surveys have been borne to a considerable extent by other countries than ours, but that the war has brought about a great stimulation of shipbuilding in this country so that our vessels have increased from 26,397 with a gross tonnage of 8,871,037 on June 30, 1917, to 27,513 with a gross tonnage of 12,907,300 at the end of the fiscal year 1919. What is more significant still is that the increase of our merchant fleet has been not in small coasting craft, but ships of a size and type adapted to ocean service. While on July 30, 1914, just before the outbreak of the great war, our seagoing merchant ships of 1,000 gross tons or over numbered only 755, of 2,128,731 gross tons, these vessels of more than 1,000 gross tons number on June 30, 1919, no fewer than 2,058, of 7,300,022 gross tons, or a net gain of more than 5,000,000 tons in vessels capable of ocean navigation.

In the sundry civil bill for the fiscal year ended June 30, 1919, the sum of $62,500 was appropriated for wire-drag launches, including their equipment for the Coast and Geodetic Survey. Out of this appropriation four 60-foot launches have been built and equipped and three 30-foot tenders. One 30-foot tender was purchased.

While these launches have been in commission but a very short time, they have already demonstrated their efficiency in carrying on our wire-drag surveys. They are trim vessels, with sufficient strength to propel the wire drags and yet economical of fuel consumption. They are especially designed for this class of work, and therefore have the proper amount of space, and in right place, for storing all the necessary equipment and implements for making wire-drag surveys. They are far superior to the weaker, lumbering fishing vessels that have been hired heretofore for pulling the wire drag and which we have been forced to alter in order to install the wire-drag equipment, reels, engines, etc. With this demonstrated efficiency and economy that has resulted from the use of these vessels especially designed for this work, there is the stronger reason that such vessels should be utilized for carrying on all our wire-drag surveys. The wire-drag vessels that have been built for us out of the appropriation for 1919 are sufficient to operate two wire-drag parties. There are four regions where the wire-drag survey only is capable of finding the hidden, underwater dangers to navigation. These are all along the coast of New England, and Long Island Sound down to the entrance to New York Harbor. In this region are found the glacial deposits of bowlders left beneath the waters bordering the coast. The second general region is the coast of Florida from Palm Beach southward around the southern shores and up to the neighborhood of Cedar Keys. In these waters the coral reefs are dangers to navigation. Some of these reefs are in the form of small islands, known locally as keys, while others are entirely submerged and are grave menaces to navigation. While coral reefs are characteristic of all these waters, the regions where wire-drag examinations are most urgently needed are in the vicinity of Key West and to the westward from there and then northward through the channels that commercial vessels take in and out of the Gulf from Mobile, New Orleans, etc. The third region where wire-drag surveys are required is in the coral-infested waters of Porto Rico and the Virgin Islands. The fourth general region where wire-drag surveys are required is along the coast and through the passages of southeastern Alaska. The danger to be found here is the pinnacle rock, which is found in the form of a narrow needle-like rock that extends from a very great depth to very near the surface of the ocean. Ordinary soundings with the lead and line are of little avail in finding these pinnacle rocks and, indeed, are often quite deceptive in that such soundings show a very considerable depth and give assurance of safety, while danger may be at hand. Instances are known where the pinnacle rocks come to within a very short distance of the surface of the water, while soundings showed depths of hundreds of feet in their immediate neighborhood. There is one other small area where the wire drag should be used. This is at the Atlantic entrance to the Panama Canal. The total area in square statute miles of these four general regions yet to be covered by the wire drag is 54,319.

From this it follows that two wire-drag parties that can be operated with the modern wire-drag vessels that we now have can only accomplish a fractional part of the wire-drag work that remains to be done. In the belief that the remedy should be applied where the danger is greatest, one of these parties is operating in Long Island Sound and the other off the coast of Maine. Wire-drag work can be effectively carried on in these waters from about the 1st of April until the close of November.

We have acquired from the Navy two fairly large power launches. While these have not been built for wire-drag purposes, we believe that with some alteration they will fairly answer for this purpose. These will be used in Alaskan waters. The wire drag requires two power launches, one at each end of the drag. These launches are too large to be used both on the same drag. A very efficient drag would be formed by using one of these launches acquired from the Navy and one of the type of those that have been built for us out of the appropriations for 1919. Therefore what is needed is four additional 60-foot launches of the type of those built out of the appropriation for 1919. Two of these in conjunction with the two launches acquired from the Navy would make up two wire-drag parties for the Alaskan waters, and the other two would provide a wire-drag party for the coast of Florida.

There is more wire-drag work than can be completed by the five wire-drag parties that would be thus provided within the lifetime of the launches, a period of about 10 years. After that time the upkeep would be excessive.

Another need of the field service of the bureau is an investigation of the possibilities of the use of the aeroplane in making topographic surveys and hydrographic examinations, as well as revision surveys. Aeroplane photographs were used to a very great extent during the war in locating military features of the enemy. The same principle can be used in surveying and mapping, but a large amount of research work will have to be done before the aeroplane photograph will give the accuracy required of the highest grade of surveying done by the Coast and Geodetic Survey.

It is a very difficult matter to keep the topographic features up to date on the 700 charts of the United States Coast and Geodetic Survey with the old methods, but it is possible in many cases and especially in a flat country, to make very rapid revision of the shore line and adjacent land areas by means of photographs taken from aeroplanes.

The mapping of the country adjacent to the shores where there is considerable relief is at present not practicable from the aeroplane on account of the great amount of work that would be involved in reducing the photograph to the map. It is believed that methods will be developed by which this will be done more expeditiously, and then there will be no limit to the character of terrain on which the aeroplane can be used for surveying.

It must not be supposed that the aeroplane can entirely supersede the usual methods of surveying. We shall still need triangulation and traverse to give the fundamental control for the work, and much planetable work will have to be done to locate topographical features which may be used in the control of the position of the aeroplane photographs. It is also probable that the planetable will still be the method for placing the contours on the map. While it is possible to obtain some idea of the relief of the country from overlapping aeroplane photographs, at the same time the problem of placing contours accurately on the map is one which will be difficult to solve. The office expense of contouring a map from aeroplane photographs will undoubtedly be greater than by an instrumental party working in the field, if the contouring is to be of a high grade of accuracy. The most promising field for surveying and mapping from an aeroplane is over flat country, or country with low reliefs, and in revision surveys where the contouring has already been accurately done. The changing features are shore lines, woods, roads, bridges, etc. These features can be readily placed on the old map by fitting in the new features shown on the photograph.

What seems to be most desirable at present is that we should have a research laboratory connected with the air service of the Army or the Navy in which various methods and instruments might be tested. Such a laboratory would preferably be in the vicinity of Washington, where the Government survey and mapping organizations are located.

### War Work of the Coast and Geodetic Survey.

The Coast and Geodetic Survey bore an important burden during the war, both in the field and in the office. All told, 268 men drawn both from the field and the office took part in the war. These were drawn from all ranks of the employees of the bureau, ranging from the Superintendent to temporary men employed by the field parties.

The bureau contributed five of its survey vessels to the fleet operated by the Navy. One of those vessels, the *Surveyor*, was employed on convoy duty to and from Mediterranean ports. While on one of these trips the convoy was attacked by two German submarines, one of which was the famous *U-39* which sunk the *Lusitania*. The *U-39* fired a torpedo which grazed the bow of the *Surveyor* and was visible from the deck of that vessel. The wake of the submarine was picked up by the *Surveyor* and she was able to get in a position for favorable discharge of the depth charge. As the *Surveyor* was unable to leave the convoy, she was unable to return and finish the submarine, but did succeed in disabling it to the extent that the submarine was compelled to enter Cartagena, Spain, and intern there. Another vessel of the bureau, the *Isis*, was on duty at New York as flagship of the commandant of squadron 2, cruiser force, from November 16, 1917, to October 14, 1918, and was on duty at Yorktown and Hampton Roads as flagship of division 4, battleship force 1, from October 15, 1918, to April 1, 1919. A third vessel, the *Bache*, was assigned to squadron 5, fifth district, and performed general salvage work, outside patrol, and guardship duty off Virginia Capes. Her primary duty was identification and passing of all inbound and outbound vessels. She was the means of communication between naval authorities and these vessels. She handled mail, gave medical assistance to passing vessels, and performed important salvage operations. Two other vessels of the bureau were assigned to patrol duty in Alaskan waters. They were the *Explorer* and the *Patterson* (re-named the *Forward*).

Besides this direct assistance to the military branches of the Government by the contribution of men and vessels, the Coast and Geodetic Survey rendered valuable service to both these branches through its field and office force. In the field, assistance consisted of furnishing certain control for maps in critical areas selected by the chief of military mapping of the Corps of Engineers of the Army. These areas were in Texas, Georgia, Florida, South Carolina, North Carolina, and Virginia. The work was chiefly triangulation, traverse, and leveling. Special hydrographic examinations were made by means of the wire drag at points designated by the Navy Department. Among such were the wire-drag surveys in Long Island Sound and in York River (Chesapeake Bay). An extensive wire-drag examination was made of the waters of the vicinity of Eastport, Me. Besides this, surveys were made for the location of points for naval fire-control experiments, the reestablishment of the speed trial course at Lewes, Del., for torpedo-boat destroyers, the location of the Port Jefferson trial course in Long Island Sound, and the Block Island (R. I.) trial course.

### Need for a New Building.

Year after year I have called attention to the need of a modern and adequate building to house the Coast and Geodetic Survey. Efficient work can never be done in a building so unsuitable for the needs of the bureau it houses.

It is physically impossible to bring together under proper supervision the different units of the organization. Where artisans, laborers, and employees of all kinds are scattered here and there in small rooms, under insanitary conditions, without proper light and ventilation, the best of results can not be expected. So acute did this become during the war, and so essential was the progress of that bureau to the successful prosecution of the war, that you authorized the use of $105,000 from your fund for the national security and defense, for the construction of a small building adjoining the present buildings occupied by the bureau to relieve the congestion. This building is now completed, and the facilities that it affords only emphasize the great drawback and handicap under which the bureau is operating in its present old quarters.

# STEAMBOAT-INSPECTION SERVICE.

(GEORGE UHLER, *Supervising Inspector General.*)

## Organization.

There were the following positions in the Steamboat-Inspection Service at the close of business on June 30, 1919:

| | | |
|---|---|---|
| At Washington, D. C. (central office force): | | |
| Supervising Inspector General | 1 | |
| Deputy Supervising Inspector General (who is Acting Supervising Inspector General in the absence of that officer) | 1 | |
| Clerks | 10 | |
| Messenger | 1 | |
| | | 13 |
| In the Service at large (field force): | | |
| Supervising inspectors | 11 | |
| Traveling inspectors | 3 | |
| Local inspectors of hulls | 48 | |
| Local inspectors of boilers | 48 | |
| Assistant inspectors of hulls | 82 | |
| Assistant inspectors of boilers | 83 | |
| Clerks to boards of local inspectors | 97 | |
| | | 372 |
| Total | | 385 |

Attention is specially directed to the small size of the central office force.

Sixty-four permanent positions were added to the Service during the year, as follows:

One supervising inspector at Seattle, Wash., and one traveling inspector with headquarters in the office of the Supervising Inspector General.

One clerk in the office of the Supervising Inspector General, Washington, D. C.

The following assistant inspectors: Two assistant inspectors of hulls and three assistant inspectors of boilers, San Francisco, Calif. Two assistant inspectors of hulls and two assistant inspectors of boilers, Cleveland, Ohio. One assistant inspector of hulls and two assistant inspectors of boilers, Philadelphia, Pa.; Seattle, Wash.; and Portland, Oreg. Two assistant inspectors of hulls and one assistant inspector of boilers, New York, N. Y. One assistant inspector of hulls and one assistant inspector of boilers, Boston, Mass.; Milwaukee, Wis.; Los Angeles, Calif.; New

London, Conn.; and Portland, Me. One assistant inspector of hulls, Baltimore, Md.; New Haven, Conn.; and Norfolk, Va. And one assistant inspector of boilers, Chicago, Ill.; Jacksonville, Fla.; and Toledo, Ohio.

Twenty-four additional clerks were added in the Service at large.

**Summary of Activities and Statistics.**

Following is a summary of activities and statistics for the fiscal year 1919:

The force inspected and certificated 7,407 vessels, with a total gross tonnage of 11,562,166, of which 7,134 were domestic vessels, with a total gross tonnage of 9,128,911, and 273 were foreign passenger steam vessels, with a total gross tonnage of 2,433,255. Of the domestic vessels there were 5,880 steam vessels, 709 motor vessels, 17 passenger barges, and 528 seagoing barges. There was an increase of 392 in the total number of vessels inspected and an increase of 3,097,470 in the total gross tonnage of vessels inspected, as compared with the previous fiscal year. Letters of approval of designs of boilers, engines, and other operating machinery were granted to 23 steam vessels, with a total gross tonnage of 672. There were inspected for the United States Government 79 hulls and 2,337 boilers. There were 2,053 reinspections of passenger and ferry steamers.

Licenses were issued to 28,069 officers of all grades. There were examined for visual defects 9,753 applicants for license, of whom 108 were found color blind or with other visual defects and rejected. Certificates of service were issued to 8,796 able seamen, and 760 were rejected. Certificates of efficiency were issued to 3,910 lifeboat men, and 344 were rejected.

Steel plates for the construction of marine boilers to the number of 35,427 were inspected at the mills, and a large amount of other boiler material was inspected. There were examined and tested 435,337 new life preservers, of which number 8,311 were rejected.

The total number of accidents resulting in loss of life was 194. The total number of lives lost was 543, of which 202 were passengers. Of the lives lost, 170 were from suicide, accidental drowning, and other causes beyond the power of the Service to prevent, leaving a loss of 373 as fairly chargeable to accidents, collisions, founderings, etc. There was an increase of 43 in the number of lives lost, as compared with the previous fiscal year. Passengers to the number of 323,317,657 were carried on vessels required by law to make report of the number of passengers carried. Dividing this number by 202, the total number of passengers lost, shows that 1,600,582 passengers were carried for each passenger lost. The number of lives directly saved by means of the life-saving appliances required by law was 2,349.

**Reconstruction.**

One of the great problems to which the Nation must give its attention is that of transportation, and, so far as transportation by water is concerned, the Steamboat-Inspection Service must necessarily have an important part, because vessels of the American merchant marine are subject to the inspection of that Service. Therefore, if there can be any improvements made in the methods of administration, those improvements should be made now, so that the American merchant marine may not only be placed in the first rank of all the nations but that it may remain there. There will be briefly discussed the proposition of an improvement to be made in the approval of hull and boiler construction, the question of the licensing of men, and changes that should be made in the law with reference to boiler pressures.

**Centralization of Approval of Hull and Boiler Construction.**

It is important at this time to improve the methods of the approval of hull construction. This could be accomplished by creating in the office of the Supervising Inspector General a corps of experts, whose business it would be to examine and pass upon blue prints and specifications submitted by persons purposing to build ships. When approved, the blue prints would be referred to the respective boards of local inspectors in whose district the vessel or vessels were to be built. The inspectors' duty would be to see that they were built in accordance with the blue prints. The result of this procedure would be to standardize in a large measure hull construction and hull inspection.

Although the regulation adopted by the Board of Supervising Inspectors in regard to the stability of vessels provides that when inspectors have any reason to question the stability of any vessel under their jurisdiction they shall require the owners of the vessel to make inclining tests on such vessel under the supervision of expert naval architects provided by this Department, the Service does not discover the condition until after the vessel is navigated and until after the risk has been assumed by those who travel upon the ship. It is proposed, therefore, to have enacted by the Board of Supervising Inspectors, without delay, a rule that will require a stability test of all vessels that are built, the tests to be conducted under the direction of naval architects provided by this Department. While this is a narrower proposition than that of the creation of a board of naval architects working under the direction of the Supervising Inspector General, it is one that will meet and possibly control the situation until proper action can be taken to provide for the corps of naval architects.

It is also quite as necessary that boiler construction should be approved in the office of the Supervising Inspector General by a corps of expert engineers in the same manner as hull construction.

It will be clear that, in order to have that uniform administration of the law with reference to the approval of hull and boiler construction, with which the Supervising Inspector General is charged, there must be centralized authority.

### Examination of Applicants for Licenses.

It has been suggested to the Steamboat-Inspection Service that, if uniform methods were used in examining applicants, a better class of licensed officers would be obtained, and that the procedure of the Civil Service Commission should be followed, so fixing one general practice in this respect. On the other hand, it may be stated that the United States covers a vast expanse of territory, representing many varied local conditions, and it is felt that, in the matter of examining applicants, the local inspectors are better informed than any central authority could ever be. Furthermore, there would be considerable congestion in connection with obtaining licensed officers for the ships. These men do not come for examination once or twice a month, but usually every day, and the local inspectors adjust their business so as to examine them when they appear. As a result, the Service has been able under war conditions to obtain licensed officers for the rapidly increasing number of ships.

### Boiler Pressure.

The rules of the Steamboat-Inspection Service are not up to date with reference to boiler pressures, proper credit is not given for the riveting plan above double riveting, and improvements can be made with reference to hydrostatic pressure. The Service, therefore, caused to be drafted a bill looking to the amendment of sections 4433 and 4418, Revised Statutes. That bill is Senate bill 574.

The purposes of the proposed amendments in section 4433, Revised Statutes, are, first, to do away with the obsolete rule contained in the law, prescribing a working steam pressure for single-riveted joints, without taking into consideration the percentage strength of the riveted joint, and allowing 20 per cent additional pressure for double-riveted joints, but not allowing a greater working pressure for triple-riveted and quadruple-riveted, etc., lap and butt joints. For these, greater working pressure should be allowed on account of the greater strength of the triple-riveted and other similar joints.

This greater allowable working pressure for the stronger forms of riveted joints has for years been desired by boiler users.

The present law furnishes no incentive for building boilers with stronger kinds of joints than double-riveted joints that will carry a greater working pressure with but slight increase in the amount of material required for boiler shell.

Further, by placing the authority to prescribe rules for working pressure on boilers with the Board of Supervising Inspectors, with the approval of the Secretary of Commerce, that board will prescribe rules that will meet the various conditions of boiler construction, taking into consideration the percentage strength of the various kinds of riveted joints.

Rules for calking would be prescribed by the Board of Supervising Inspectors in connection with rules for riveted joints.

The purpose of the amendments in section 4418, Revised Statutes, is in order to leave with the Board of Supervising Inspectors the authority of determining the hydrostatic test in connection with the rules for riveting that would be adopted by the board and approved by the Secretary of Commerce.

The proposition of giving the Board of Supervising Inspectors the authority to make modern its rules with reference to boiler pressures is consistent with the whole theory of reconstruction. It is absolutely necessary that it be adopted, in order that the rehabilitation of the American merchant marine may go forward without delay.

### Civil Service for the Supervising Inspectors.

The supervising inspectors of the Steamboat-Inspection Service are not under the classified civil service. They are all presidential appointees. They should be under the classified civil service. Quite generally the supervising inspectors are men who have been promoted from the position of local inspector. When they come from the position of local inspector, they come out of the classified civil service, and they should be given the same protection under the classified civil service when they become a supervising inspector. At every presidential election there is a feeling of uneasiness and uncertainty as to what the future of the supervising inspectors will be. That condition ought not to exist, and, looking to increased efficiency in the Steamboat-Inspection Service, I urgently recommend that this important branch of that Service be placed under the classified civil service.

## BUREAU OF NAVIGATION.

(Eugene Tyler Chamberlain, *Commissioner*.)

American shipping registered for the foreign trade and enrolled and licensed for the coasting trade, including the fisheries, on June 30, 1919, comprised 27,513 vessels of 12,907,300 gross tons, compared with 26,711 vessels of 9,924,518 gross tons on June 30, 1918, an increase of 802 vessels and 2,982,782 gross tons. The following statement shows the total of our tonnage at the close of each of the past six fiscal years and indicates the great changes which have taken place within that period:

| June 30— | Foreign trade. | Coasting trade. | | Total. |
|---|---|---|---|---|
| | | Great Lakes. | Sea and rivers. | |
| 1914 | 1,076,152 | 2,882,922 | 3,969,614 | 7,928,688 |
| 1915 | 1,871,543 | 2,818,000 | 3,699,886 | 8,389,429 |
| 1916 | 2,191,715 | 2,760,815 | 3,517,119 | 8,469,649 |
| 1917 | 2,446,399 | 2,769,824 | 3,654,814 | 8,871,037 |
| 1918 | 3,603,706 | 2,708,523 | 3,612,289 | 9,924,518 |
| 1919 | 6,669,726 | 2,635,680 | 3,601,894 | 12,907,300 |

These figures show for the dates named the gross tonnage of ships registered, enrolled, or licensed; but they must not be taken unqualifiedly as the evidence of commercial growth. Of the total tonnage 3,827,201 gross tons were vessels over 1,000 tons owned by the Shipping Board and represent appropriations by Congress and the sacrifices made by the American people to win the war. The figure just stated does not fully represent the extent of the Government's ownership in ocean carrying, for on June 30, 1919, the War and Navy Departments were operating mainly as troop transports 405,021 gross tons of ships, including most of the former German merchant ships seized in American harbors. These ships are not under register or enrollment on account of their temporary employment, but in any adequate statement of our maritime resources should be added to the 3,827,201 gross tons of Shipping Board ships.

Since 1914, as during the Napoleonic wars, American ships have appeared in large numbers in ports all over the world. Of the total increase in our shipping since June 30, 1914, almost 5,000,000 gross tons, nearly all has consisted of ocean-going steel steamers of 1,000 gross tons or over, of which on June 30, 1914, we had 429 of 1,589,733 gross tons and on June 30, 1919, 1,436 of 6,072,901 gross tons. Though effected by war causes, this growth is in the direction of normal mercantile-marine development. The increase, on the other hand, in wooden seagoing steamers of over 1,000 gross tons from 8 of 10,595 gross tons on June 30, 1914, to 293 of 693,541 gross tons on June 30, 1919, is to be counted in large measure as among our sacrificial efforts to win the war.

The vessels built in the United States and documented as vessels of the United States during the fiscal year numbered 1,953 of 3,326,621 gross tons, compared with 1,528 of 1,300,868 gross tons during the previous fiscal year. The standard by which the output of the United States should be measured is that of the rest of the world during prewar years. During the calendar year 1913, the year of the greatest prewar output, Lloyd's returns show a total of 1,932,153 gross tons launched in the United Kingdom, her greatest output, and 1,124,276 gross tons launched by the rest of the world, excluding the United States, a grand total of 3,056,429 gross tons. During that year the United States launched 276,448 gross tons. In a word, the people of the United States, mainly through war loans and war taxes, have expanded the shipbuilding industry until in tonnage output it has equaled the world's former annual commercial output of shipping. It is quite evident that this great industry can be maintained only if it is in a position to meet not merely the requirements for new tonnage of American shipowners, but also the requirements of shipowners of other nations less favorably placed by natural causes and legislative support than are we for shipbuilding.

**World's Tonnage.**

The world's merchant tonnage is larger now than at any other time in history. Lloyd's Register for 1914 stated the world's total tonnage (vessels over 100 gross tons) at 49,089,000 gross tons, and the same authority for 1919 gives the world's total as 50,919,000.

A comparison of the volume of tonnage will be seriously misleading unless the quality of the tonnage also is considered when estimating the work it can now perform. About two-thirds of the tonnage now afloat was built before the war and has undergone not merely five years of ordinary wear and tear, but, in addition the strain of constant service, with limited repairs hastily made. Furthermore, submarine warfare was directed against the best types of passenger ships, and the loss of ocean liners was especially heavy. This has been partly, not wholly, made good by the transfer of the former German passenger fleet to the flags of the maritime powers. The repair and restoration to a fair measure of usefulness of the ships built before the war has been undertaken, but it has involved temporary withdrawal of considerable tonnage.

The ships built during the war, taken as a whole, are inferior to the ships built before the war. This statement involves no reflection upon shipbuilders and shipowners. Indeed, they have had much less authority than usual over the plans or methods of ship construction, Government here and abroad having assumed virtually entire control over the building and operation of ships. The aim of Government generally has been to turn out the greatest volume of tonnage in the shortest possible time. The average speed of ships built during the war was below the average of prewar construction. Very few passenger ships were built, and the urgent need for engines involved the building of cargo boats slower on the average than those building in 1914. The average size of ships was also smaller, because many of the yards formerly engaged in building larger ships were employed during the war on naval construction, and many of the new yards hastily established could turn out only smaller ones. Finally, hurried workmanship by labor in process of training can not be expected to produce the best results. The new oil-burning ships have, however, plain advantages in many trades over coal-burning ships.

These factors in the situation, though not easy to reduce to mathematical form, must be weighed in drawing conclusions from a comparison of the world's total tonnage now and before the war.

A true guide for present purposes would be a statement of the tonnage clearances of shipping in the world's foreign trade by sea, but such a statement is not now available.

The total clearances with cargo, however, from the ports of the United Kingdom for ports in foreign countries (excluding Germany) and British possessions during the seven months ended July 31, 1919, were 19,286,256 net tons, compared with 13,114,208 net tons for the corresponding period in 1918 and 36,261,475 net tons for the corresponding period in 1914. The tonnage clearances from the United States for Europe, Asia, Australia, Africa, and South America for several fiscal years are at hand, stated in net tons (each of 100 cubic feet of closed-in ship space). The following table shows the shipping actually available and employed for cargo and passengers clearing in overseas trade from the United States during the fiscal year ended June 30, 1914, the year of our greatest clearances before the war, during the year ended June 30, 1918, and the year ended June 30, 1919:

| For— | 1914 | 1918 | 1919 |
|---|---|---|---|
| Europe | 16,144,118 | 14,263,547 | 16,431,123 |
| South America | 2,429,659 | 2,237,976 | 2,705,365 |
| Asia and Oceania | 1,990,105 | 2,095,324 | 2,529,998 |
| Africa | 406,457 | 235,649 | 393,971 |
| Total | 20,970,339 | 18,832,496 | 22,060,457 |

From the clearances for Europe are excluded those for Germany, of which in 1918 there were none and in 1919 only 9,734 net tons, but 3,902,073 net tons in 1914. The figures for 1918 and 1919, however, do not include the shipping employed in transporting troops and our munitions of war, which greatly exceeded the tonnage clearances in previous times for Germany.

In ordinary times, on account of the greater bulk of our exports, ships usually clear from the United States with ample cargoes, while many enter in ballast or with part cargoes. In 1914, for example, 15 per cent of the shipping from Europe entered the United States in ballast, and at the present time the proportion is much greater, though the precise figures are not at hand. To a greater extent than usual, accordingly, foreign consumers must pay high freights on their imports from the United States, for those freights must often cover the charges of the voyage in ballast to America. Evidently such conditions can not long continue.

So far as the production of shipping to meet the situation is concerned, good progress is shown by Lloyd's report that on June 30, 1919, the merchant ships under construction in the world's yards aggregated 8,017,767 gross tons, of which 3,874,143 gross tons were building in the United States and 2,524,050 in the United Kingdom. The largest tonnage building under prewar returns was 3,445,000 gross tons reported by Lloyd's for June 30, 1913.

The growing share of American shipping in the overseas trade of the United States is shown by the following statement of the net tonnage of clearances of American ships for overseas during the fiscal years ended June 30, 1914, 1918, and 1919:

| For— | 1914 | 1918 | 1919 |
|---|---|---|---|
| Europe | 439,261 | 1,671,081 | 2,535,265 |
| South America | 192,479 | 823,354 | 1,290,248 |
| Asia and Oceania | 100,833 | 287,386 | 494,548 |
| Africa | 4,263 | 49,460 | 99,034 |
| Total | 736,836 | 2,831,281 | 4,419,095 |

As in the preceding statement of total net-tonnage clearances (which included American), these figures do not include Germany, to which in 1914 the American clearances amounted to 8,406 net tons, none in 1918, and 9,734 net tons in 1919.

The net tonnage of many merchant ships converted into Army transports are not included in the figures above.

**Main Maritime Facts.**

The main facts in the general maritime situation at this time are as follows:

1. The world's merchant tonnage is the largest in history, but its average efficiency is below that of 1914 for inherent reasons in construction and for extraneous reasons such as port congestions, labor troubles, and management. The world's net gain in steam tonnage is 2,500,000 gross tons, the gain of the United States 7,600,000 gross tons, the loss of the rest of the world 5,100,000 gross tons.

2. The merchant tonnage now under construction is more than double the prewar output and is of increasing efficiency in the main.

3. The volume of the world's ocean-borne commerce is less than in normal times and will continue less until industrial and agricultural Europe has more fully recovered from the effects of the war.

The proportion exports to Europe bear to the world's total sea-borne commerce is above the average, involving high ocean-freight rates.

Our maritime situation, mainly as the result of expenditures authorized by Congress equal to the book value of the whole world's merchant fleets in 1914, is as follows:

1. Our seagoing steel steam tonnage (ships of over 1,000 gross tons) on June 30, 1919, was over 6,000,000 gross tons, four times greater than in 1914, and is increasing at the rate of over 350,000 gross tons a month, equaling our best annual outputs before the war.

2. The annual output of our shipyards exceeds the greatest annual output of the world's shipyards before 1914.

3. Steel-ship building plants have been extended or established with new machinery, methods, housing, and transit accommodations equal, and in some respects superior, to those abroad.

4. American tonnage clearing in overseas trade in the fiscal year 1919 was six times greater than in 1914.

### Maritime Problem.

The maritime problem now before the United States is more difficult than in former years, because we have created with public funds a vast war plant of ships and shipyards which must be readjusted to the requirements of commerce.

Few will contend that shipbuilding and ship operation can be successfully maintained and developed in this country if Government is to furnish the funds and almost exclusively control both, as for the past two years. The question of raising the money by loans and taxes for the purpose is not for the moment in mind, though evidently there is a limit to that not far off in time. The building and operation of ships are two forms of industrial activity which least of all admit of monopoly or combination. The ocean is free to those who wish to navigate it. The most ingenious legislative devices, even in war times, have not restricted the individual of any country, except an enemy, from purchasing ships where he chooses and operating them. Limitations may be prescribed and obstacles erected, but these confirm the essentially competitive nature of shipbuilding and shipowning. These occupations accordingly offer some of the best fields for individual skill, application, enterprise, and foresight and the least advantageous fields for a system of Government ownership and management in which the qualities named are more likely to be stunted than developed.

It seems clear, therefore, that the restoration of our maritime affairs to individual control and operation is desirable for the healthy development of our national life. The sooner this action is taken the better for the future of the industries, because the next two years bid fair to be the crucial years in commercial maritime development. By that time it is reasonably safe to presume that the world's ocean-borne trade will be conducted on terms of the closest and, it may be hoped, the fairest competition.

American shipyards, accordingly, should be allowed to build freely for all comers, and in the long run they will gain by the withdrawal on equitable terms of Government contracts and the substitution therefor of private contracts. We already have steel-ship building plants nearly all of which are equal to and many superior to the older plants of other countries. The past two years have developed hundreds of thousands of shipbuilders who numbered only tens of thousands before the war. The supremacy of our steel industry is unchallenged. The same general principles should be considered in relation to the fleet afloat, the ships in operation or launched. Every interest suggests that these ships be disposed of to men trained to the most effective and economical operation of ships. The industrial and commercial situation of the world is too uncertain to warrant experiments in the operation of ships which might be inviting in times of general prosperity.

There will doubtless be opportunity, and probably necessity, for some lines operated either partially or indirectly by the Government in which to provide an outlet for our commerce to points that can not be profitably reached by private enterprise until commerce with them shall have been developed. Our ocean fleet is the servant of our trade, and where that trade can not be served effectively by private enterprise the Nation, through the Government, must do its part in opening the way in which our commerce is to flow. There is room, therefore, in the ocean trade for full and free opportunity for private enterprise and for the helping hand of the Government to meet special conditions in order that our commerce and industries shall by both be adequately served.

### Subdivision of Hulls.

The recommendations of the International Conference on Safety of Life at Sea, in so far as they relate to the subdivision of hulls and other structural details of ocean passenger ships, have been held in abeyance during the war, although British trans-Atlantic passenger ships have been built during the period in voluntary compliance with those recommendations. Although during the war we confined our efforts to building cargo ships, we must now include ocean passenger ships, and the recommendations of the conference and experience gained from the past five years should be considered in making plans for such ships. The subject called for prompt action, and I have accordingly requested the American members of the construction committee at the international conference to recommend a course of action and the administrative machinery required. These gentlemen—Rear Admiral W. L. Capps, U. S. Navy; Mr. Homer L. Ferguson, president of the Newport News Shipbuilding & Dry Dock Co. and of the Chamber of Commerce of the United States; and Mr. Alfred Gilbert Smith, president of the New York & Cuba Mail S. S. Co.—are of acknowledged standing and authority. It will undoubtedly be desirable to provide for a small technical staff to be permanently attached to the Department of Commerce to consider questions of the construction of passenger ships, whether the conference regulations or modifications of them be adopted.

### Shipping Commissioners.

During the year 485,796 officers and men have been shipped and discharged, included repeated shipments and discharges, by United States shipping commissioners, compared with 457,248 for 1918 and 506,941 during 1917. Collectors of customs acting as shipping commissioners at ports where those officers are not established shipped and discharged last year 37,978 men, compared with 35,131 for the previous fiscal year and 18,439 for the fiscal year 1917. The great increase in American shipping in foreign trade is not reflected in these figures, because during the war our ships were manned to a great extent by men in the Navy. These naval crews are being discharged and merchant crews provided, as contemplated by law, for merchant ships. The work of shipping commissioners is increasing, especially at the principal seaports, and it has been necessary to submit deficiency estimates to cover this increase.

### Navigation Receipts.

The receipts from tonnage duties during the fiscal year amounted to $1,265,229.23 (including $2,041.98 Philippine Islands fund and $5,028.50 alien and penal tonnage duties and light money). The total is $93,810.87 greater than for the previous fiscal year. The largest annual receipts from tonnage duties were $1,454,565.83 for the year ended June 30, 1916, and during the current fiscal year receipts from this source should become normal and approach that amount.

Receipts from navigation fees amounted to $143,492.19, compared with $146,508.02 for the previous year. The receipts from navigation fines and penalties amounted to $162,146.50, compared with $32,097.68 for the previous year. The increase is almost wholly due to the forfeiture of the steamer *Sacramento*. This ship was a former German ship which by fraud secured an American register at San Francisco and forthwith under German direction proceeded with supplies to the squadron of Admiral von Spee, off the Juan Fernandez Islands, thus enabling that squadron to sail to its destruction off the Falklands. The steamer *Sacramento* was decreed forfeited and the forfeiture compromised for $250,000, of which $125,000 was paid last year, and the balance is to be paid during the current fiscal year.

The total navigation receipts for the year thus have been $1,570,867.92, compared with $1,351,492.66 for the previous fiscal year. It may be noted that the appropriations by Congress for all branches of the Navigation Bureau amounted to $217,045.

### Radio Communication.

Under the Executive order of April 30, 1917, "to insure the proper conduct of the war against the Imperial German Government and the successful termination thereof" coast radio stations were operated by the Navy Department or closed, and the order is still in force, pending ratification of the treaty of peace. The Navy Department continued the supervision of the allotment of radio apparatus to ship and shore stations and supplied naval radio operators to many ships. The regular force of radio inspectors of the Bureau of Navigation continued to serve with our armed forces ashore and afloat, and I am pleased to add that the value of their services in many instances has been recognized by our Government and the Governments of the allies by promotion and by the award of decorations. Many of our force have now been honorably discharged from the Army or Navy and with a few exceptions have returned to the bureau.

During the past year the bureau's Radio Service made 4,243 inspections on ships subject to the radio ship act, compared with 4,341 similar inspections during the previous fiscal year and, in addition, 917 inspections of the apparatus on ships voluntarily equipped. The inspections developed 425 cases of apparatus more or less defective or of inadequate complement of radio operators.

The inspection of ship apparatus was of the first importance for security, particularly during hostilities. It was not possible with the force available to make the critical examination of apparatus preliminary to the issue of licenses to ship stations under the act to regulate radio communication and the treaty to which it gives effect. Only 250 ship stations were thus fully examined, but, in addition, provisional licenses were issued to 1,196 ship stations. In some instances the apparatus for these stations was furnished by the Navy Department and was at times necessarily incomplete or imperfect. In addition, 866 ships are equipped with wireless apparatus, requiring licenses which it has not been practicable to issue even provisionally.

This branch of the work is very much in arrears, and the laws can be carried out only by a considerable increase in the inspection force for which a deficiency estimate has been submitted to Congress. On July 1, 1915, only 897 American ships were equipped with apparatus for radio communication, while on July 1, 1919, the number was 2,312. Meanwhile the appropriation for the maintenance of the wireless-inspection service in all its branches has remained $45,000. With the coming of peace it will be necessary not only to overcome the arrears, but to provide for regularly continuing inspection, which soon will involve three times the number of American ships subject thereto in 1915.

The total number of examinations of applicants for radio operator's license was 2,729. One thousand one hundred and twenty-four passed the examinations and received operator's licenses. In addition, the licenses of 579 operators were renewed. After years of effort, the Bureau of Navigation has secured for its license to radio operators a reputation in the technical world so that the license is sought for as an evidence of proficiency by foreign operators, as well as by our own. The bureau decided not to lower the standard of its examination and license, but to meet emergencies due to the shortage of radio operators by authorizing inspectors to allow operators with some experience, but unable to pass the examination, to go to sea under a temporary permit. At the end of the fiscal year June 30, 1919, there were outstanding 48 commercial extra first-operators' licenses, 2,436 commercial first licenses, and 610 commercial second licenses, in all 3,094 operators, a number insufficient even if all were fully employed all the time to fully man the 2,312 American ships equipped with radio apparatus on June 30, 1919. The deficiency, however, is being partly overcome by the radio inspectors, who are instructed to give special attention to the examination of operators.

The examination and license of amateur operators and stations ceased in April, 1917. The amateur field has recently again been opened.

The volume of radio inspection will thus be very much greater than it was before the war; furthermore, the commercial radio equipment of the near future will differ in many respects from that of the past because of the improvements, developments, and inventions resulting from the intensified use of radio communication during the war. More flexible and efficient equipment will come into use, including the radio telephone. The invention and improvement of directional radio apparatus by which position may be determined, to a great extent the result of investigations by an expert in the Bureau of Standards, this Department, have a special and obvious value at sea. Improvements in the tuning of apparatus permit a greatly increased amount of traffic. Radio telegraphy in certain localities where the maintenance of wire lines is impossible for physical reasons or prohibited on account of cost must hereafter be reckoned with. The wonderful advances in aerial navigation with the use of wireless for communication between ships in the air and stations on the earth introduces another complication.

The subject of the scientific development of radio communication during the war is too technical and complicated to be set forth in detail in this report. It is mentioned as showing that operators hereafter must have a broader theoretical training and a more accurate knowledge of the radio art than hitherto, the standards of the inspection service and the scientific qualifications of the inspectors must be advanced. These considerations have led the Department to ask for a deficiency appropriation of $55,000 to meet conditions and requirements when radio communication resumes its normal place as an instrument of commercial communication.

### International Radiotelegraphic Conference.

The developments in radio communication and the great improvement in transoceanic radio communication point to the need of a revision of the International Radiotelegraphic Convention of 1912, to which the United States is signatory. The International Radiotelegraphic Conference adjourned at London with the understanding that the next conference should be held in 1917. The war made that impossible, but all are agreed that the conference should be held as early as possible in 1920, and Congress will be asked to provide for American representation.

**Load Line, Measurement, Bulkheads.**

The necessity for legislation to provide for load lines on cargo vessels has been referred to in my former reports. A bill (S. 575; H. R. 3621) embodying the views of this Department has been favorably reported to the Senate and the House of Representatives. The bill enables the Secretary of Commerce to avail himself of the facilities afforded by the American Bureau of Shipping and gives that useful organization an official status, establishing relations between our Government and the American bureau similar to those between the British Government and Lloyd's Society. To give effect to the legislation, several high-grade technical experts will be needed in the Department of Commerce, and at some ports it will be necessary to provide officers competent to make the surveys preliminary to the establishment of load lines in the case of ships which are not classed by the American bureau or by other classification societies. The estimates to give effect to the load-line bill, if enacted, are being prepared.

In my report for 1917 mention was made of the need for creating in seaboard and Great Lakes shipbuilding districts a small corps of men trained to the accurate measurement of ship tonnage instead of relying upon the detail of customs inspectors. This matter has not been pressed during the war. Hundreds of ships have been built in this period from a few sets of plans supplied by the Government simplifying the work of measurement. When one ship of a certain type had been carefully measured, it was necessary merely to send blue prints and results for their guidance to customs officers in districts where other ships of the same type and dimensions were under construction. In normal times many ships are built with regard to the particular trades in which they are to engage. This is the only way in which the fullest use can be secured from them and is necessary to success in the highly competitive business of shipping in foreign trade. In time we shall return to normal conditions. The Department of Commerce will then require a force of measurers of ships. Legislation and the estimates to give it effect await surer signs of the return to normal conditions in shipbuilding than are now in sight.

With the return of normal conditions it will be necessary also to give closer attention to bulkheads and other important details of construction.

Here, too, any intelligent action by the Government will require a small technical staff in the Department of Commerce and officers at certain seaports capable of giving effect understandingly to its recommendations and conclusions.

The three subjects load line, measurement, and bulkheads involve considerations of the safety of the ship and those on board which are paramount. They involve also issues of commercial competition on equal and fair terms. For both reasons it is plainly desirable that there should be substantial accord between the maritime powers in their legislation and administrative measures. Again, conditions at present are too remote from normal to warrant the suggestion of early and formal meetings of the maritime representatives of those powers to consider measures to effect such accord. It is not, however, too early to begin those informal conversations which necessarily must go before more formal action, and the Bureau of Navigation has the general subject under consideration.

**Enforcement of Navigation Laws.**

During the year 1919 the various services of the Bureau of Navigation reported 8,172 violations of the Navigation Laws, the largest number acted upon by this Department since its creation. These violations resulted in the collection of $162,146.50 as fines, the largest amount collected from this source at least during the last 25 years, due mainly to the collection of a single penalty of $125,000 in the case before described.

The work of enforcing the law was performed through the offices of the collectors of customs, navigation inspectors, Steamboat-Inspection Service, and the Department's inspection boats. In addition to these, 56 owners of motor boats, most of them members of the United States power squadron, tendered their services and boats on Sundays and holidays at $1 per year.

During 1919 there were 11,071 counts of passengers going on excursion steamers aggregating 7,783,791 passengers, as compared with 4,916,772 passengers for the previous year. Of this number the navigation inspectors made 7,380 counts of 6,250,948 passengers.

On 408 occasions it was found necessary to prevent more passengers going on board vessels. This involved the safety of 186,307 passengers. The navigation inspectors are employed only during the months of June, July, and August. While not counting passengers they are employed in the general enforcement of the navigation laws, especially those relating to motor boats.

During the fiscal year passenger ships on 314 voyages brought 55,603 steerage passengers to the United States, compared with

67,988 such passengers in 1918, 147,493 passengers in 1917, 154,057 in 1916, 211,057 in 1915.

**Motor Boats.**

The general resumption of the use of motor boats has extended the usefulness of our inspection vessels in safeguarding the lives of those using them.

The act of June 7, 1918, requiring the numbering of undocumented motor boats went into effect December 7, 1918, and is quite generally complied with, especially in those sections where we have facilities for the enforcement of the law. Up to July 1 of this year there had been numbered 91,916 motor boats. It is estimated that there are approximately 250,000 motor boats in the United States, perhaps 200,000 of which are subject to this law. For its enforcement it is essential that the Department should have additional facilities.

There have been turned over to us by the Navy Department two small motor boats used by them during the war as station patrols which are especially adapted to our service. The House Committee on Appropriations has included in the deficiency bill for 1920 a provision which will enable us to place these vessels in operation about the first of March and continue their use during the balance of the fiscal year. We will thus be able to cover with our five vessels the Atlantic and Gulf coasts, Mississippi River and tributaries, and place one vessel on the Great Lakes.

The inspection forces of the Bureau of Navigation are cooperating with the Internal Revenue Bureau in the collection of taxes imposed on the use and business of motor boats. The revenue derived from the work of these inspection boats of the Department in the collection of taxes and navigation fines should be greatly in excess of their cost of operation.

# CONCLUSION.

## Need for a Unified Government Commercial Organization.

Section 3 of the organic act of February 14, 1903 (32 Stat., 825), provides as follows:

> It shall be the province and duty of said Department to foster, promote, and develop the foreign and domestic commerce, the mining, manufacturing, shipping, and fishery industries, the labor interests, and the transportation facilities of the United States; and to this end it shall be vested with jurisdiction and control of the departments, bureaus, offices, and branches of the public service hereinafter specified, and with such other powers and duties as may be prescribed by law.

So much of the foregoing as relates to labor interests is superseded by the organic act creating the Department of Labor. The balance remains in full force and vigor. There is no other department of the Government charged by law with the broad duty to foster, promote, and develop the foreign and domestic commerce, etc., of the United States. It is assumed that this law was meant to be taken seriously; that the duties imposed by it upon the Department of Commerce were real duties; and that it should have the authority and the responsibility of performing them. It is, perhaps, not too much to assume that the Department of Commerce was, within the sphere which is above outlined, intended to have the same authority and influence that the Treasury Department has in finance, the War and Navy Departments in their respective fields of military effort, the Agriculture Department in the field of agriculture, the Department of State in diplomacy, and, indeed, each of the other executive departments within its lawful field.

Such is, however, not the case. Other bodies exist who perform in whole or in part the duty charged by law upon the Department of Commerce. In writing frankly of the actual situation it should be premised that the matter is not discussed in any spirit of complaint, nor is there any thought of criticism of persons or of specific bodies. The subject under review is a matter of organization, and the question being discussed is whether our present organization is fitted to cope effectively with the serious commercial problems that face the country.

Any review of the commercial work of the Government must show that the absence of organization is its most conspicuous feature. There is an excess of organizations; too little system. Numerous bodies exist, functioning more or less in the same field or with direct action therein, each independent, without coordination, without liaison, without the obligation on the part of any of them to inform the others. In short, there exists in our public commercial organization very much the same condition that existed in the allied armies before unity of command was secured. It would not be questioned that before that time the commanders of the allied and associated forces were sincere, competent, and devoted men. Each, in his own separate sphere, was doing his best and trying to support his allies as fully as he could. The difficulty was, of course, that the spheres were separate. Just so it is in our Government commercial organization. Different bodies, composed of able and earnest men, function separately on commercial subjects at home and abroad, without mutual plan, without frequent consultation, and often in entire ignorance of what the others are doing.

The War Finance Corporation is given authority to furnish credits to the extent of a billion dollars "in order to promote commerce with foreign nations." There is no doubt this function will be performed by them wisely and well, so far as the law permits; but there is no obligation to coordinate their work with that of the Department of Commerce, although this last is charged to "foster, promote, and develop the foreign and domestic commerce" of the country. The management of the War Finance Corporation has shown marked courtesy to the Department of Commerce, but there exists no close cooperation.

The Federal Reserve Board admirably performs a function of vital importance to our commerce and finance. One can only speak of it in terms of approval and admiration, but, so far as the Department of Commerce is concerned, it functions separately, without obligation of either consultation or of cooperation.

The Interstate Commerce Commission performs functions of high value in our domestic and foreign commercial life; but it performs them as a separate organization. It probably does not occur to the distinguished members of that useful body to either consult or cooperate with the Department of Commerce, or that the latter has any interests or functions in common with it.

The Shipping Board provides for the carrying of our commerce to the ends of the earth and, through its officers and representatives abroad, takes an important, if not a vital, part in our commercial activity, but the Department of Commerce is not represented upon the Shipping Board and, except as a matter of courtesy, can not influence or guide it.

The Federal Trade Commission has duties of high importance vitally affecting our domestic and our foreign trade; but no representative of the Department of Commerce forms a portion of that body, nor is there existing any obligation for that commission to function in close relation with the Department of Commerce.

The International High Commission, of which the Secretary of the Treasury is the ex officio chairman, is a composite body representing the United States and the other American Republics. It has distinctly commercial functions, among them the provision of uniform regulations for commercial travelers, of uniform arrangements for the classification of merchandise, for customs regulations, for consular certificates and invoices, and for port charges. It gives special consideration to the protection of patents and trade-marks and deals with the extension of arbitration for adjusting commercial disputes. It is a useful and dignified body, whose work touches closely that of the Department of Commerce. It is in no respect inharmonious, but it is separate. The Department of Commerce has no legal relation to it. A list of its publications is found upon page 59 of the Hearings Before the Committee on Foreign Affairs, House of Representatives, Sixty-fifth Congress, third session, on the diplomatic and consular service appropriation bill, under date of December 11, 1918.

The Railroad Administration, through its power to embargo freights, to grant or remove export rates, may at times exercise a controlling power over both our domestic and foreign commerce; but it has under the law no relation to the Department of Commerce and, save as a matter of courtesy, does not assume that there is any joint field of endeavor.

The Department of State, for reasons admitted by all to be good and sufficient, maintains foreign-trade advisers and a force for the purpose of gathering foreign-trade information. The relation between that department, especially through its Consular Service and the foreign-trade advisers and the Department of Commerce, is intimate and cordial. It has been a privilege to express admiration for the fine and fruitful work of the Consular Service. There is a "no man's land" wherein the diplomatic field runs parallel with the commercial and the commercial field touches closely upon the diplomatic. It will probably always be necessary to maintain a species of joint endeavor between the two departments.

The Department of Agriculture, through several services, assists or supervises large commercial transactions at home and abroad, and does so ably and with advantage to the country.

Again, let it be emphasized that the relations between these various bodies are not frictional, but cordial. The men comprising the various groups are friends. They realize they are working to a common end. I repeat, the question is not one of individuals, but one of organization. There can be no clear-cut commercial policy carried out by separate bodies in the commercial field that do not interfunction. Any industrial organization composed as is the commercial organization of the Government would fail, for the seeds of decay are planted in the very separateness of the component parts. It is not urged that these bodies should cease to be or that their functions should be altered. There are separate duties belonging to each, although many of those duties lie in a common field with the Department of Commerce.

It is, however, strongly urged that each and every one of these separate services should be linked formally to that Department which alone the law charges with the duty to "foster, promote, and develop the foreign and domestic commerce" of the country.

Is there sound reason why there should not be a representative of the Department of Commerce upon the War Finance Corporation, upon the Federal Reserve Board, upon the Federal Trade Commission, upon the Shipping Board, upon the Interstate Commerce Commission, or upon the Railroad Administration? If such reason exists, what is it? On the other hand, is it the public purpose and intent that the Department charged to "foster, promote, and develop the foreign and domestic commerce" of the country should do it only in part, subject to the kindly and unintentional, but nevertheless real, competition and control of others charged with different duties, indeed, but so acting as in some measure to perform or to control the performance of this work?

Very clearly either the Department of Commerce should be so organized as to perform its important function effectively or it should not. If it should not do so, then the organic law dictating its functions should be modified, and it should cease to be in name what it is hardly in fact, the Department of Commerce. Or, on the other hand, it should be recognized that it is really the center of commercial organization on the part of the Government, and as such these various independent bodies should so be headed up into it that the world of commerce and the business man may know there is one head for commerce as there is one for agriculture, as there is one for war, as there is is one for the Navy, and not a congeries of unrelated parts which operate, indeed, in personal harmony and peace, but without those effective results which alone can come from systematic and unified effort.

The foregoing report is respectfully commended to your attention and to that of Congress.

Respectfully,

William C. Redfield,
*Secretary.*

# APPENDIXES.

## Appendix A.—VESSELS FOR THE UNITED STATES LIGHTHOUSE SERVICE—URGENT NECESSITY FOR REPLACEMENT OF VESSELS WORN OUT AND DESTROYED.

### Services Performed by Lighthouse Vessels.

In the operation of this the most extensive lighthouse service in the world, covering 47,300 miles of general coast line and rivers, there are at present employed 117 vessels, of which 54 are tenders and 63 are light vessels.

The tenders serve both as supply ships and buoy tenders, carrying supplies and personnel to lighthouses and lightships, placing and caring for buoys, and doing construction, repair, and inspection work. They are the arteries of the Service, and maintain a continuous patrol of the entire coast of the United States. If anything is amiss with lightship, lighthouse, or buoy, they are promptly dispatched in aid, and very frequently succor other vessels or persons or property in danger.

The light vessels are floating lighthouses, located in the most important positions for safeguarding shipping. Many of them are on very exposed and hazardous stations off our coasts. Equipped with distinctive lights, powerful fog signals, submarine bells, and radio communication, and guarding the dangerous points of the coast and the approaches to the great harbors, they are the most indispensable of the aids to navigation.

No vessels are exposed to more severe usage than the vessels of the Lighthouse Service; the tenders are continuously in service, and handle buoys of great weight in proportion to the size of the vessel, as well as quantities of coal and other supplies. In working buoys the tenders must navigate close to the edge of reefs and shoals, and in waters which other vessels shun. Furthermore, the light vessels must remain at anchor in exposed positions during the most severe gales and hurricanes. The handling of buoys and supplies must often be done in a seaway, under difficult or dangerous conditions.

### Relation to Other Government Activities.

The United States is investing largely in shipping. The total amount authorized or appropriated by Congress for the Emergency Fleet Corporation to October 15, 1918, was $3,671,000,000, covering the purchase and construction of over 3,100 vessels, or more than double the number of seagoing merchant vessels of the United States at the beginning of the war. The expenditures of the Navy Department for the construction of new vessels for the fiscal year 1918 were about $450,000,000. The expenditures for vessels for the Lighthouse Service should be considered as one of the relatively small items of insurance for this great investment of the Government in shipping, as well as for all the privately owned shipping of this country and the shipping of other countries which visits our shores. The United States expends about $40,000,000 a year in river and harbor improvements. The maintenance of the aids to navigation is indispensable if these improvements are to obtain their maximum usefulness.

### Present Condition of Vessels and Necessity for Upkeep.

Under normal conditions the useful life of a lighthouse tender is about 25 years and of a light vessel about 30 years. The average age at present of the vessels of the Lighthouse Service is for tenders 22 years and for light vessels 28 years, and for each class this average age has increased by 3 years since 1914, owing to lack of replacement of vessels. Of the light vessels now in use 20 are more than 30 years old and of the tenders 17 are more than 25 years old. Some of the light vessels are over 50 years old.

To maintain 54 tenders and 63 light vessels of a useful age it is evident that on an average 2 tenders and 2 light vessels must be built each year, and the recommendations and estimates submitted have yearly emphasized this fact. In the 9 years since 1910, however, but 11 tenders and 7 light vessels have been built, a total of 18, or less than half the number of replacements necessary to maintain the Service on its former basis, without allowing for any increase. However, since 1910 the number of aids to navigation maintained by this Service has increased from 11,660 to about 16,075, a total increase of 4,415, or 38 per cent, and 3 new districts—Alaska, Porto Rico, and Hawaii—have been added; also the number of gas buoys maintained has increased from 225 to about 600, and the number of automatic gas shore lights has increased from 117 to about 600. All of these increases, and particularly the gas buoys and automatic shore lights, have added greatly to the work of the tenders; so that notwithstanding important economies in tender service that were effected at the reorganization in 1910, the present number of tenders, even if they were efficient modern vessels, has become inadequate to maintain the Service as required in the interest of navigation. Many of the present tenders are, moreover, of a type not suitable to perform efficiently the work required (4 of them are side-wheel vessels built 36 or more years ago) and were not designed to handle the heavy gas buoys which have been developed since they were built. Some of them are not sufficiently seaworthy to be sent on outside work on account of their age, and a great deal of time is lost in making the frequently needed repairs. Many of the present lightships are not suitable to be placed on exposed stations. The cost of repairs and overhaul becomes so heavy that it is not economical to keep in commission vessels after they have reached a reasonable limit of usefulness. The continued use of these old vessels often results in a greatly diminished output with the same or greater cost of operation and upkeep. Of more importance than the question of efficient and economical operation, however, is that of safeguarding life. Both lighthouse tenders and lightships are engaged on hazardous duty, and their officers and crews should not be required to serve on vessels which have passed a reasonable limit of usefulness, nor can the Lighthouse Service properly perform its part in the safeguarding of life and property on the navigable waters of this country without necessary vessel equipment.

### Recent Conditions Affecting Vessels.

The deficiency of vessels in the Lighthouse Service has been accentuated by an unusual number of casualties in the last year and a half. Since January, 1918, Diamond Shoal light vessel has been sunk on station by a German submarine, Cornfield Point light vessel has been run into by a barge and sunk on station, Cross Rip light vessel has been destroyed by the ice, Thirty-Five Foot Channel light vessel has been destroyed by fire at a contractor's dock, and Bush Bluff light vessel and the tender *Gardenia* have been condemned as worn-out and not worth repair.

All the tenders of the Lighthouse Service, except one, were by your order placed on duty with the Navy Department during the period of the war, and from April, 1917, to July, 1919, have been performing various duties for that department in addition to their regular lighthouse work. Some of this naval duty, such as the handling of protection nets, has been strenuous work for these vessels. As a result of this, as well as the shortage of tenders and the difficulty of effecting repairs under war conditions, there has been an unusual deterioration of vessels. Experience of the last two years has proven that the lighthouse vessels are of especial value in time of national emergency. This is an additional reason for the proper maintenance of these vessels. The tenders are the best available type of small vessels for handling moorings, nets, etc., and the light vessels are valuable signal stations at strategic points off the coast.

No appropriations for lighthouse vessels have been made since the act of June 12, 1917, or for more than two years. Of the appropriations made at that time, that of $150,000 for a tender for the third district has been impracticable to use, as the lowest bid received for the vessel was $333,800, and, on readvertising, $357,250, not including equipping the vessel. The appropriation of $150,000 intended for two small light vessels for the Great Lakes was barely sufficient to contract for one such vessel. Present conditions in the shipbuilding industry render it impossible to use several appropriations or balances of appropriations, as they are quite insufficient under present shipbuilding costs. Under the appropriation of June 12, 1917, of $130,000 for a light vessel, recent bids were $297,000, $396,700, and $496,000 for the vessel, without outfit.

Due to war conditions and insufficiency of appropriations, no new contracts for lighthouse tenders have been made since September, 1915, and since June, 1916, only one light vessel has been contracted for.

Very thorough investigation has been made as to the possibility of obtaining vessels suitable for work of the Lighthouse Service from the Shipping Board or from vessels no longer needed by the Navy. It was found that the Shipping Board had no vessels in any way suitable. From the Navy two small vessels have been transferred which will be used for shoal-water tender work, but will be of but limited usefulness. Both lighthouse tenders and light vessels are vessels of unusual requirements, and it is impracticable to meet the special needs of this work by adapting vessels built for other purposes.

**Essential Program for Maintenance of Vessels for Lighthouse Service.**

From careful estimates and examinations as to the condition and further serviceability of vessels of the Lighthouse Service, it is found that within the next five years 18 light vessels and 10 tenders, as shown in the following list, should be replaced with vessels of the types indicated, and 1 light vessel should be built for new station. As it will require under favorable conditions from two to three years after appropriation is made before vessels are available for service, funds should be provided now for 17 of these vessels urgently needed, in addition to 3 vessels for which estimates have been heretofore submitted, 2 to be built under the authorization of June 20, 1918, and 1 to replace Diamond Shoal light vessel.

The vessels for which appropriation should be made now are the following, with estimated cost:

*To replace Diamond Shoal light vessel.*

| | Estimated cost. |
|---|---|
| Light vessel to replace *No. 71*, Diamond Shoal, fifth district, class 1 | [a] $450,000 |

*To be built under authorization of June 20, 1918.*

| | |
|---|---|
| Tender to replace *Jessamine*, fifth district, class B | 400,000 |
| Tender to replace *Gardenia*, third district, class B | 400,000 |
| Total | [b] 800,000 |

*Additional vessels, authorization of which is now necessary.*

| | |
|---|---|
| Light vessel for Barnegat, N. J. (new station), class 2 | 335,000 |
| Light vessel to replace *No. 51*, relief, third district, class 2 | 335,000 |
| Tender to replace *John Rodgers*, third district, class B | 400,000 |
| Tender to replace *Holly*, fifth district, class B | 400,000 |
| Tender to replace *Mistletoe*, third district, class B | 400,000 |

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[a] Covered by pending deficiency bill. [b] Covered by pending deficiency bill in amount of $760,000.

| | |
|---|---|
| Light vessel to replace *No. 43*, relief, eighth district, class 2 | $335,000 |
| Light vessel to replace *No. 20*, Cross Rip, Mass., second district, class 2 | 335,000 |
| Light vessel to replace *No.* 3, Handkerchief, Mass., second district, class 2 | 335,000 |
| Tender to replace *Goldenrod*, fourteenth district, river | 100,000 |
| Light vessel to replace *No. 11*, Scotland, N. J., third district, class 2 | 335,000 |
| Light vessel to replace *No. 44*, Northeast End, N. J., third district, class 2 | 335,000 |
| Light vessel to replace *No. 68*, Fire Island, N. Y., third district, class 2 | 335,000 |
| Light vessel to replace *No. 69*, Overfalls, Del., third district, class 2 | 335,000 |
| Light vessel to replace *No. 46*, Tail of Horseshoe, Va., fifth district, class 2 | 335,000 |
| Light vessel to replace *No. 56*, North Manitou, Mich., twelfth district, class 3 | 160,000 |
| Light vessel to replace *No. 57*, Grays Reef, Mich., twelfth district, class 3 | 160,000 |
| Light vessel, to replace *No. 60*, Eleven-Foot Shoal, Mich., twelfth district, class 3 | 160,000 |
| Total | 5,130,000 |

On May 15, 1919, in a letter to the Speaker of the House of Representatives in connection with legislation affecting the Lighthouse Service, this Department requested that a provision be included authorizing the "Constructing or purchasing and equipping lighthouse tenders and light vessels for the Lighthouse Service, $5,000,000." This, with the estimates pending, would provide for the above immediate necessities. The large number of new vessels required now is directly due to the conditions of recent years, which have prevented replacement of vessels in this Service at a proper rate. The situation is not unprecedented, however, for in the sundry civil act of March 4, 1907, appropriations were made for building or completing 21 light vessels and tenders, and an amount of $2,180,000 was included for vessels; for 10 of these vessels there had also been previous appropriations.

The building of vessels for this Service should not be deferred on account of present shipbuilding costs. The expense will undoubtedly be higher than the costs a few years back, but there is no likelihood of any early reduction in shipbuilding costs. This replacement of vessels has already been so repeatedly deferred on account of war conditions that the fleet of this Service is in a seriously depreciated condition, which can not safely be permitted to continue. The costs of these vessels on a tonnage basis will be higher than costs announced by the Shipping Board for building fabricated ships for the following reasons: The lighthouse vessels are small, are of a special type, will be built in small numbers, and must be unusually stanch for their size; also, the Shipping Board per ton price does not include investment charges and depreciation of plant, which every contractor must include in bidding on work. The Lighthouse Service can, however, undoubtedly obtain more favorable bids by constructing, as is proposed, several vessels of one type at one time. The following are some comparisons as to the costs of vessels of small size and special types, somewhat comparable with the required vessels for the Lighthouse Service. In January, 1919, the Coast Guard contracted for building five cutters, at $687,000 each; these vessels are of 1,200 tons construction weight, or will cost $572 per ton. The tender *Cedar*, completed in 1917, according to sworn statements of the contractors, cost $448 per ton construction weight to build; since 1917 there has been material increase in cost of shipbuilding. The lowest bids, received within the past year, were $565 per ton for the tender *Oak*, and $539 per ton for a vessel for the Coast Survey. The recent contract price for steel barges for the upper Mississippi River was at $401 per ton; these barges are of much simpler construction than seagoing vessels. The above comparisons are on the basis of construction weight, actual weight of vessel without supplies or load.

*List of lighthouse vessels requiring replacement within the next five years (not allowing for any losses of vessels).*

| Vessel. | Age. | Remarks. | Replace by— | Necessary to build. |
|---|---|---|---|---|
| LIGHT VESSELS. | *Yrs.* | | | |
| No. 71—Diamond Shoal | ..... | Sunk by submarine. | New ship | Class 1, light vessel. |
| No. 51—Relief | .... | Sunk by collision | ....do | Class 2, light vessel. |
| No. 55—Lansing Shoal | 28 | Worn out | L.V.No. 99 (building) | |
| No. 43—Relief | 38 | ....do | New ship | Do. |
| No. 20—Cross Rip | 52 | ....do | ....do | Do. |
| No. 62—Bar Point | 26 | ....do | Canadians will provide | |
| No. 61—Huron | 26 | ....do | L. V. No. 103 (building) | |
| No. 3—Handkerchief | 67 | ....do | New ship | Do. |
| No. 11—Scotland | 66 | ....do | ....do | Do. |
| No. 44—Northeast End | 37 | ....do | ....do | Do. |
| No. 68—Fire Island | 22 | ....do | ....do | Do. |
| No. 69—Overfalls | 22 | Less exposed station | ....do | Do. |
| No. 46—Tail of Horseshoe | 32 | Worn out | ....do | Do. |
| No. 56—Manitou | 28 | ....do | ....do | Class 3, light vessel. |
| No. 57—Grays Reef | 28 | ....do | ....do | Do. |
| No. 60—Eleven - Foot Shoal. | 26 | ....do | ....do | Do. |
| No. 73—Pollock Rip Slue | 18 | Less exposed station. | ....do | Class 2, light vessel. |
| No. 48—Cornfield | 28 | Worn out | L. V. No. 73 | |
| No. 34—Charleston | 55 | ....do | New ship | Class 1, light vessel. |
| No. 70—San Francisco | 22 | ....do | ....do | Do. |
| No. 39—Brenton Reef | 44 | ....do | L. V. No. 69 | |
| TENDERS. | | | | |
| Jessamine | 38 | Worn out | New tender | Class B, tender. |
| Gardenia | 40 | Condemned | ....do | Do. |
| John Rodgers | 36 | Worn out | ....do | Do. |
| Holly | 38 | ....do | ....do | Do. |
| Mistletoe | 47 | ....do | ....do | Do. |
| Goldenrod | 31 | ....do | ....do | Class, special. |
| Arbutus | 40 | ....do | ....do | Class B, tender. |
| Lilac | 27 | ....do | ....do | Class A, tender. |
| Snowdrop | 23 | ....do | ....do | Class B, tender. |
| Myrtle | 47 | ....do | ....do | Do. |

*Additional vessels required for new station.*

| | |
|---|---|
| Light vessel, Barnegat, N. J. | Class 2 |
| Tender for Alaska | Class B |

*General types of vessels proposed.*

| Vessel. | Length. | Construction weight and cost. | Estimated cost. |
|---|---|---|---|
| LIGHT VESSELS. | *Feet.* | | |
| Class 1, most exposed stations | 147 | 615 tons, at $650 per ton | $400,000 |
| Class 2, exposed stations | 135 | 515 tons, at $650 per ton | 335,000 |
| Class 3, Great Lakes stations | 96 | 240 tons, at $650 per ton | 160,000 |
| TENDERS. | | | |
| Class A, seagoing | 190 | 1,000 tons, at $650 per ton | 650,000 |
| Class B, coastwise | 170 | 620 tons, at $650 per ton | 400,000 |
| Class special, inland rivers | 150 | 250 tons, at $400 per ton | 100,000 |

# Appendix B.—THE DOGFISH CAMPAIGN AND CONTROVERSY, AND THE INCREASED CONSUMPTION OF FOOD FISHES.

There is widespread interest in the dogfishes, their ravages, and the measures proposed for their amelioration, and there has been much misconception and misstatement regarding the relations of the Department of Commerce to the movement for combating the dogfish nuisance by making commercial utilization of these fishes.

It therefore seems desirable that a full statement on this subject should be made, particularly in view of recent criticism in Congress in which the dogfish campaign was associated with another wholly unrelated activity of the Department and was used in a misleading argument for defeating a meritorious service hitherto successfully executed for the purpose of increasing the consumption of aquatic products, adding to the food supply, and reducing food costs.

For many years the fishermen of the New England coast have complained of their serious losses from the destruction wrought by dogfishes, two species of small sharks which appear in the coastal waters in large schools during the summer. A related species, with similar habits, is the subject of like complaint on the Pacific coast. Measures intended for the relief of the fishermen from this serious trouble, embodying in one form or another the payment of a bounty, have been considered by Congress.

On May 2, 1913, Hon. Asher Hinds, of Maine, introduced in the House of Representatives the following bill (H. R. 4584, 63d Cong., 1st sess.):

A **Bill** To protect our national food supply by the extermination of certain enemies of food fishes of the Atlantic coast.

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled*, That a Federal bounty of not less than 2 cents shall be paid by the United States for each dogfish or dogfish shark caught and exterminated by citizens or fishermen of the United States in the waters of the Atlantic Ocean between Cape Hatteras and Eastport, Maine, by the delivery of the tail section only of said dogfish or dogfish shark to such vessels, works, or places as may be designated, which shall be paid for on delivery to the United States Government authorities, under regulations prescribed by the Secretary of Commerce.

Sec. 2. That the Department of Commerce shall annually, in the estimates made to the Congress of the United States of the sums required or deemed necessary to be raised for its department, recommend such a sum to carry out the provisions of this bill as it deems requisite to accomplish the purpose herein intended, and which shall include all sums necessary for carrying out completely the objects herein sought, the extermination of said dogfish.

Sec. 3. That this Act shall go into effect on its passage.

At the request of the chairman of the Committee on the Merchant Marine and Fisheries, the Department made the following report of its views on this bill in a letter from the Acting Secretary to the chairman of the Committee on the Merchant Marine and Fisheries, House of Representatives, dated April 21, 1914:

In reply to your letter of April 15 enclosing a copy of H. R. 4584, "To protect our national food supply by the extermination of certain enemies of the food fishes of the Atlantic coast," you are advised that the Department believes that the principle involved in the proposed legislation is inimical to the public interest. If the practice of paying bounties for the destruction of the enemies of food fishes is begun it will eventually develop into a burden on the Nation. It will be but a question of time when the demand will arise for bounties on star-fishes, drills, and drumfishes which destroy great quantities of oysters, on the dogfish of the Great Lakes and the garfishes of the same waters and the Mississippi Valley, and a host of other aquatic animals concerning which more valid pleas can be raised than in respect to the dog shark.

The Department does not believe that the latter is as destructive to food fishes as is generally supposed, although it is a great nuisance and a source of loss to the fishermen. Both of the common species are principally bottom feeders, and the fragments of food fishes found in them are generally baits stolen from the lines or fish eaten from the nets. There is even no support for the reiterated statement that the species found on the Maine coast is destructive to lobsters, the quotations to that effect attributed to the publications of the Bureau of Fisheries applying to the southern species.

The Bureau of Fisheries estimates that about 2,700,000 dogfish were taken in the fisheries on Georges Bank, South Channel, and Nantucket Shoals alone in 1913, which would require the payment of $54,000 in bounties under the provisions of this bill in addition to the costs of administration. It is believed that $500,000 annually would be required to give effect to the proposed legislation. Moreover, there would be no way by which the Department could assure itself that the dogfish tails on which bounties were claimed were from fish taken within the limits prescribed in the bill and undoubtedly there would arise a lucrative business of importing dogfish tails from other parts of the coast.

I recommend an adverse report on this bill.

On May 9, 1913, Hon. Charles F. Johnson, of Maine, introduced in the Senate the following bill (S. 1868, 63d Cong., 1st sess.):

**A Bill To preserve our national sea-food supplies and reserve and to assist in fertilizing the land to better the conditions of our farmers, our fishermen, and ultimate consumers of food by Federal fertilizer utilization of small sharks, called dogfish, also several species of unutilized salt-water fishes, all preying upon and destroying our national sea and shore fisheries, of enormous commercial and economic value, as plainly shown in and by the United States Bureau of Fisheries Document numbered Six hundred and twenty-two, dated nineteen hundred and seven.**

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That a Federal bounty of not less than 2 cents each, or a purchase price of not less than $8 per ton of two thousand pounds, shall be paid to the American fishermen from Eastport, Maine, to Cape Hatteras for the labor and expense attending the catching of and delivery of the entire carcasses of the said small sharks, called Dogfish, to the proper Federal authorities at Federal dogfish and shark reduction works, when and where established between said places upon the Atlantic coast, or to such Federal collecting vessels as may be designated by the proper Federal authorities.

The said purchase price of not less than $8 per ton shall also be paid to American fishermen for all said sharks, skates, and other shark species delivered by said fishermen to said dogfish and shark reduction works, or delivered to said Federal collecting vessels as may be designated by the proper Federal authorities.

SEC. 2. That by and under the authority of the proper Federal authorities not less than twenty-five to one hundred of said Federal dogfish and shark reduction works, with a daily reduction capacity of not less than fifty tons dogfish or sharks, shall be located, built, equipped, and operated at the most suitable and efficient points from Eastport, Maine, to Cape Hatteras, as efficient or more efficient than those of Canada, built since nineteen hundred and three, including one of said reduction works located, built, equipped, and operated at or near Eastport, Maine; one of said reduction works at or near Cutler, Maine; one of said reduction works at or near Jonesport, Maine; one of said reduction works at or near Milbridge, Maine; one of said reduction works at or near Stonington, Maine; one of said reduction works at or near Vinal Haven, Maine; one of said reduction works at or near Boothbay, Maine; one of said reduction works at or near Elm Island, near Orrs Island, Maine; one of said reduction works at or near Bangs or Stave Island, Casco Bay, Maine; one of said reduction works at or near Woods Island, Maine; one of said reduction works at or near Cape Porpoise, Maine; one of said reduction works at or near Portsmouth, New Hampshire; one of said reduction works at or near Monhegan Island, Maine; one of said reduction works at or near Newburyport, Massachusetts; one of said reduction works at or near Gloucester, Massachusetts; one of said reduction works in or near Boston Bay, Massachusetts; one of said reduction works at or near Cape Cod, Massachusetts; one of said reduction works at or near Woods Hole, Massachusetts; and at such other places southward on the Atlantic coast as may be designated by the proper Federal authorities between Eastport, Maine, and Cape Hatteras.

SEC. 3. That regular annual sums of money sufficient shall be appropriated to operate and maintain efficiently all the said dogfish and shark reduction works that are located, built, equipped, and operated at all places between Eastport, Maine, and Cape Hatteras, and the said sums of money shall be sufficiently large to pay the said American fishermen not less than 2 cents Federal bounty on each said dogfish caught and delivered to said described Federal authorities in said manner, and to pay said fishermen not less than $8 per ton purchase price for all sand sharks, skates, and other shark species, including the dogfish, delivered to said Federal authorities in manner herein described.

SEC. 4. That the said sums of money so appropriated shall be sufficiently large to pay the said fishermen not less than 2 cents Federal bounty on each dogfish and upon the basis of the probable delivery of one million dogfish or more annually at each said Federal dogfish and shark reduction works.

SEC. 5. That the said Federal reduction works shall be manned ready for operation when located, equipped, and built for a period of time not less than from June first to November first annually.

SEC. 6. That all dogfish or shark fertilizers produced at said Federal reduction works shall be sold only and direct to the bona fide farmers and planters of the United States, and said fertilizer shall contain no filling or make weight of non-fertilizer materials, and the price of said fertilizers shall be only the gross cost of production of said fertilizers, and the said fertilizers shall be bagged and the analysis of said fertilizer in said bags shall be plainly stamped thereon, showing the particular nitrogen, phosphoric acid, and bone phosphate contents in any form, in pounds and percentage; likewise of nitrogen, phosphoric acid, or bone phosphate; and all orders for said fertilizers from bona fide farmers and planters received by the said proper Federal authorities shall be filled and shipped in regular order of receipt.

SEC. 7. That all rules, regulations, estimates, and expenditures, necessary concerning the locating, building, equipping, and operating of the Federal dogfish and shark reduction works, and disposition of said fertilizer, oil, and other by-products derived from the reduction of said dogfish or other sharks or unutilized fishes, shall be made by or under the direction of such proper Federal authorities as may be determined by Congress and the President of the United States, but all said rules and regulations shall not be in conflict with the provisions of this Act.

SEC. 8. That this Act of Congress shall go into effect from the date of its passage and as herein specified.

In response to a request for an expression of opinion on this bill, the following report was made by the Department in a letter from the Acting Secretary to the chairman of the Senate Committee on Fisheries, dated October 24, 1913:

The Department is in receipt of your letter of the 20th instant, transmitting a copy of Senate bill 1868, providing for the purchase of dogfish by the federal government, or the payment of a bounty thereon.

The Department has for some time been accumulating information on the entire subject of dogfish and their utilization, in the expectation that there would be a hearing before the appropriate committees of Congress. The question is so large and has so many features that it could not well be discussed within the limits of an official letter. I therefore venture to express the hope that your committee will hold a hearing on this bill at some convenient time and give the Department an opportunity to present its views in regard to the merits of this bill and of similar bills which have from time to time been introduced in Congress.

No definite action appears to have been taken on either of these bills; and, urged by the fishery interests, particularly of Maine, Mr. Hinds, acting on behalf of the Committee on the Merchant Marine and Fisheries, requested the Commissioner of Fisheries to draft a bill which would meet the practical requirements and have some prospect of passage. Accordingly the following bill (H. R. 16477, 63d Cong., 2d sess.) was prepared and submitted by Mr. Hinds on May 12, 1914, and favorably reported by the House Committee on the Merchant Marine and Fisheries on June 8, 1914, with an amendment providing "that the said sum [to be appropriated by authority of sec. 3] shall not exceed $15,000 in any fiscal year":

**A Bill To conduct investigations and experiments for ameliorating the damage wrought to the fisheries by predaceous fishes and aquatic animals.**

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That the Commissioner of Fisheries be, and he is hereby, authorized and directed to conduct investigations and experiments for the purpose of ameliorating the damage wrought to the fisheries by dogfish and other predaceous fishes and aquatic animals.

SEC. 2. That the said investigations and experiments shall be such as to develop the best and cheapest means of taking such fishes and aquatic animals, of utilizing them for economic purposes, especially for food, and to establish fisheries and markets for them; and for these purposes the Commissioner of Fisheries is authorized to employ such persons as may be necessary, and to catch, buy, or otherwise obtain, and to sell at cost or less or distribute gratuitously such quantities of the said aquatic products as may be necessary for tests or demonstrations of their qualities or the establishment of a demand among prospective consumers: *Provided*, That the proceeds of any such sales shall be accounted for and covered into the Treasury as miscellaneous receipts.

SEC. 3. That the Commissioner of Fisheries, through the Secretary of Commerce, shall submit in his annual estimates of appropriations for the Bureau of Fisheries an estimate of the sum of money necessary to give effect to this Act.

This bill was amended on the floor of the House of Representatives by the elimination of section 2 and by the reduction to $5,000 of the annual appropriation authorized, and was passed on February 3, 1915.

Objectionable features of this bill, from the standpoint of the Bureau of Fisheries, were set forth in the following letter from the Commissioner of Fisheries to me, dated February 5, 1915:

I desire to call to your attention certain facts relating to H. R. 16477, which was amended and passed by the House of Representatives on February 3. The bill was prepared by this Bureau at the request of Representative Hinds, its proponent, and as a step towards a practical solution of the problem presented by the damage to the fisheries by predaceous fishes, and particularly the dogfish.

As you will recall, various bills having for their purpose the destruction of dogfishes have been introduced in Congress, but all of them have received adverse reports from the Department on account of their economic and scientific defects and their manifest inadequacy to accomplish their avowed purposes.

I am convinced that the destruction of any quantity of dogfishes, sufficient to materially reduce their destructiveness, is chimerical, and that the only rational thing to do is to convert them to usefulness, and a source of profit instead of loss, by bringing them into consumption as food. This can not be accomplished by mere investigation and experiment, and the bare publication of the results. It will require in addition an active practical campaign in introducing and marketing the products and bringing them to the consumer's actual physical attention and test, in other words, an elaboration and extension of the methods which were employed in introducing the sea mussel. I am of the opinion that in the sea mussel propaganda the bureau's discretion in the expenditure of its appropriation was stretched to its limit, and I should not care to be responsible for an elaboration of that kind of work unless given additional authority, the character of which is indicated in section 2, of H. R. 16477, a copy of which is inclosed.

The amendments which the bill suffered were the total elimination of section 2 and, a comparatively minor matter, the reduction of the permissible appropriation to $5,000 in any fiscal year. The emasculated bill leaves the bureau with no more powers than it already possessed, and is, therefore, wholly futile and unnecessary, while on the other hand it places a limit, not previously imposed, on the appropriation for which an estimate may be submitted.

Unless section 2, or an essentially similar provision, can be supplied as a Senate amendment and retained in the bill in conference, it will be worse than useless to pass it:

This proposed legislation rested without further action by the Sixty-third Congress.

The Legislature of the State of Maine had authorized the appointment of a commission for investigating the dogfish nuisance, and that body pressed the Maine delegation in Congress for action toward the abatement of the trouble by establishing Government reduction works and paying bounties along the lines provided in above bills. Senator Johnson and Mr. Hinds, therefore, again submitted bills identical in terms with H. R. 16477, Sixty-third Congress, second session, excepting that the annual appropriation authorized was increased to $25,000. The House Committee on the Merchant Marine and Fisheries reported the bill (H. R. 11254, 64th Cong., 1st sess.) favorably, after hearings at which representatives of the Bureau of Fisheries, this department, the Maine Dogfish Commission, and others interested expressed their views. The report submitted by this committee was as follows:

## PREDACIOUS FISHES AND AQUATIC ANIMALS.

MARCH 8, 1916.—Committed to the Committee of the Whole House on the state of the Union and ordered to be printed.

[Mr. Hinds, from the Committee on the Merchant Marine and Fisheries, submitted the following report (to accompany H. R. 11254).]

The Committee on the Merchant Marine and Fisheries, having had under consideration the bill (H. R. 11254) to conduct investigations and experiments for ameliorating the damage wrought to the fisheries by predacious fishes and aquatic animals, report the same back with the recommendation that the bill do pass.

For 15 years at least and perhaps much longer, this committee has had referred to it bills dealing with the so-called dogfish nuisance. At first it was proposed to offer a bounty for dogfish, and afterwards to use them for fertilizer; but it was not until the Sixty-third Congress that the committee formulated a definite proposition with the concurrence of the Commissioner of Fisheries, and in that Congress a bill was reported and passed the House but was not considered in the Senate. Meanwhile the Maine Legislature had taken the matter into consideration and a commission was appointed to go to Washington and make known the extent to which the fisheries are being interfered with. One of the Maine commissioners has met the Secretary of Commerce, and the following correspondence shows the importance of this subject:

"DEPARTMENT OF COMMERCE,
"OFFICE OF THE SECRETARY,
"*Washington, February 9, 1916.*

"MY DEAR JUDGE ALEXANDER: The inclosed copy of letter to Mr. Luther Maddocks regarding the dogfish will explain itself.

"Yours, very truly,

"WILLIAM C. REDFIELD, *Secretary.*

"Hon. J. W. ALEXANDER,
"*House of Representatives, Washington, D. C.*"

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"DEPARTMENT OF COMMERCE,
"OFFICE OF THE SECRETARY,
"*Washington, February 9, 1916.*

"MY DEAR MR. MADDOCKS: In response to your request for information as to the methods proposed by the Bureau of Fisheries to deal with the dogfish problem, I beg to advise you as follows:

"We asked in the Sixty-third Congress authority to make a special study of this subject, including an appropriation of $15,000, with the view to determining whether the dogfish could be introduced as food and whether it had any other economic values that could be made available. The bill failed of passage in such form as to give us the requisite funds and authority. We have asked Senator Johnson to consider with the chairman of the House Committee on the Merchant Marine and Fisheries the introduction of this measure at the present Congress with a view to an appropriation of $20,000. If this bill shall pass we will undertake immediately upon its passage to put a force of trained experts upon the problem and to use all our powers toward its early and satisfactory solution.

"We are strongly hopeful that a demand would be created for the fish for use as several varieties of food and possibly for other purposes. In any event, we think the experiment should be thoroughly tried and shall be very glad to try it. I have assured Senator Johnson that I will appear before his committee or the House Committee on Fisheries and do anything in my power to get the thing started.

"We doubt the lawful power of the Government to enter into the fertilizer end of the matter and think it quite possible that the study we purpose to make, if given the authority and the funds, may be quite as efficacious, if not more so.

"Yours, very truly,

"WILLIAM C. REDFIELD, *Secretary.*

"Mr. LUTHER MADDOCKS,
"*St. James Hotel, Washington, D. C.*"

"DEPARTMENT OF COMMERCE,
"BUREAU OF FISHERIES,
"*Washington, February 17, 1916.*

"THE SOLICITOR, DEPARTMENT OF COMMERCE:

"In reply to your letter of February 14, requesting an expression of opinion of House bill 11254, 'To conduct investigations and experiments for ameliorating the damage wrought to the fisheries by predacious fishes and aquatic animals,' I report thereon as follows:

"This bill is intended primarily and immediately for the relief of the fishermen of the Atlantic coast, and eventually those of the Pacific coast, from the effects of the ruinous inroads of dogfishes. These are small sharks which congregate in schools, and there are two species common on the Atlantic coast, the spiny dogfish found north of Cape Cod and the smooth dogfish occurring in a more southerly habitat. These differ more or less in habits, but are alike in being great nuisances on account of their practice of eating baits and seizing the food fish caught on line and in nets. It is not believed by the bureau that the smooth dogfishes, at least, destroy very considerable numbers of free fish—that is, those which are uninjured or untrammeled by nets. The food of the smooth dogfish consists mainly of bottom animals, mussels, scallops, sea snails, crabs, starfishes, etc., and it also, unlike the spiny dogfish whose food is less known, in certain places and at certain seasons destroys considerable numbers of lobsters. The stomachs of both species often contain food fishes and fragments of fishes, but there is good reason to believe that they come largely from lines and nets.

"The fishermen justly regard these small sharks with strong disfavor as sources of annoyance and of very considerable loss to the fisheries, and in many places fishing has to be abandoned when the dogfish appear.

"Three methods of meeting this situation have been proposed: (1) To offer a bounty for the destruction of the fish; (2) to establish a number of Government-owned reduction works for their conversion into fertilizer and oil, paying for the fish in excess of their economic value in order to induce the fishermen to catch them; and (3) to endeavor to establish them in the markets as a food fish, using the liver, oil, eggs, and skins as economic by-products.

"The first two proposals are predicated on the assumption that the dogfish can be exterminated or materially reduced in number, a belief to which the bureau can not subscribe. Both of the little sharks are found on the European and American coasts and they range over the greater part of the North Atlantic. They are highly nomadic and a school on the coast one week may be far away the next and may never return. Their wanderings are so wide, their numbers so great, and the reservoir from which the coastal visitors may be drawn is so vast that it is futile to expect that catching them at even a considerable number of places along shore can have a material effect in reducing their numbers.

"If these fish could be utilized for fertilizer at even a small profit there would be justification for their use in that way, but the experience of the Canadian Government, which operates three dogfish-reduction works, shows that they can be converted into fertilizer only at a heavy loss, and this experience is corroborated by this bureau's investigations of the oil and fertilizer constituents of the fish.

"The proposition to pay a bounty, without utilizing the fishes, is open to obvious objections.

"While the bureau is opposed to these proposed measures on account of their impracticability and economic unsoundness, it is in sympathy with their purpose, and it believes that H. R. 11254, on which you now ask an opinion, affords an opportunity to attack the problems involved and in the course of time to solve them in a manner to afford relief to the fishermen and benefit to the people as a whole. The belief is entertained that the proper method of procedure is not to exterminate the dogfish by indiscriminate destruction, but to convert a nuisance into an economically useful product and a source of profit. It is believed that the only way in which this can be accomplished is to induce the utilization of this pest as food. Although this has been scoffed at by some who would be the first and principal beneficiaries, the project is practical and economically sound. The dogfish is not eaten in the United States solely on account of prejudice. It is palatable and nutritious, and its food is but little different from that of the haddock and other valued food fishes. It is extensively eaten in Europe, and during the past few years it has grown in favor in England, where 5,000,000 pounds, with a value to the fishermen of $82,000 were marketed in 1914. This large and increasing production of a cheap and excellent food is a boon to the people at large, while the fishermen receive about $28 per ton for their catch as against $8 which they would receive if the Government were to engage in the unprofitable production of fertilizer under the conditions recently proposed in this country.

"To introduce the dogfish or any other unutilized fish into consumption in the face of general prejudice and ignorance of its qualities, and the lukewarm interest of the fishermen themselves, will require time and a well-considered practical campaign. It will involve demonstrations and publicity to acquaint the people with the qualities of the fishes and the methods of cooking and preparing them and marketing experiments on a commercial scale. H. R. 11254 appears to give authority for effective work of this character, and moreover it makes it possible to extend it not only to the dogfish, but to other marine pests of equal or greater destructiveness. The bureau regards the bill as a piece of valuable constructive legislation, and urges that it be given favorable consideration and passed.

"I am inclosing a memorandum on the dogfishes which was submitted to a preceding session of Congress when a similar measure was under consideration.

"H. M. Smith, *Commissioner.*"

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"Department of Commerce,
"Office of the Solicitor,
"*Washington, February 14, 1916.*

"Hon. J. W. Alexander,
"*House of Representatives; Washington, D. C.*

"My Dear Judge Alexander: I am in receipt of yours of the 12th instant, inclosing H. R. 11254, 'to conduct investigations and experiments for ameliorating the damage wrought to the fisheries by predacious fishes and aquatic animals,' and asking my opinion with reference to the merits of the bill and the wisdom of enacting the same into law. The department approves this bill in every particular, and earnestly hopes that it will be enacted into law. I have forwarded your letter to the Commissioner of Fisheries, asking him for a special report, and as soon as it is received I will forward it to you.

"Yours, very truly,

"A. L. Thurman, *Solicitor.*"

The Bureau of Fisheries has made a careful study of the dogfishes, and this interesting subject is herewith attached to this report as a "Memorandum respecting dogfishes":

"The dogfishes are little sharks, weighing, when adult, from 5 to 15 pounds. They get their popular name from their habit of traveling in large schools or packs like dogs or wolves, and their chief present interest to the fishermen arises from their predacious habit and ravenous appetite. They feed solely on animal food, which they get wherever it is most readily obtainable, and on the fishing grounds this is usually on the trawl lines or in the nets of the fishermen.

"Trawl lines are long, stout lines to which shorter lines, each with a hook, are attached at intervals of about 6 feet. They are stretched on the bottom, held in place by suitable anchors, and marked by buoys, and as a single dory or fishing boat will often fish several thousand hooks, each baited with a piece of herring, alewife, or other fish, the fishing banks are strewn with food which the dogfish finds acceptable and readily obtainable. When a school of dogfish appears, they greedily seize these baits and either carry them away or are themselves hooked, the result to the fishermen being essentially the same in either case, for the line, set for merchantable fish, is either denuded of its lures or is loaded with dogfish for which the fisherman can find no market. The address and rapacity of these pests is such that when they are on the banks or along shore in large bodies the baits are seized before the valuable fish can take the hook, and the fisherman loses his time, the labor expended in setting and hauling his lines, the value of his bait, and all of the other items which enter into the expenses of the fishery.

"In the case of the gill-net fishery, the dogfishes are attracted by the helpless food fishes enmeshed in the nets, and they either tear them bodily away and devour them or bite them in two, leaving nothing but the head to show where a valuable fish had been. Worse than this in some respects is the damage wrought to the nets, the sharp teeth of the dogfish cutting them like shears and often leaving of the poor fisherman's property little but a string of tatters attached to the foot and lead lines.

"Under these conditions the fisherman can do nothing to protect himself, and his only recourse to save his property and avoid an utter waste of effort is to abandon the fishery, often his only source of livelihood, until such time as his enemy has departed. This is no rare occurrence, but a common one on all parts of the New England coast, over a wide stretch of the Pacific coast as well, and to some extent on the shores of the Middle Atlantic States. Even the purse seiner fishing at sea will sometimes inadvertently inclose a school of dogfish and have his net cut and torn to pieces, the pound-net fisherman along shore will find his trap filled with dogfish to the exclusion of fish of value, and lobster pots take dogfish instead of lobsters.

"The loss entailed by the destruction of gear and the enforced abandonment of the fisheries by all classes of fishermen over wide areas amounts to large sums annually. The Massachusetts Fish and Game Commission states that the observable damage to the fisheries of that State alone can be conservatively estimated at not less than $400,000 per year, and this loss to those immediately concerned must have its reflex in the increased cost of fish to the consumer. The effects of the dogfish nuisance, therefore, are not only observable over a considerable part of the immediate coast line, but are indirectly distributed over the large section of the country depending on the sea for its supply of fish. Owing to the abundance of the dogfishes, their wide distribution, their remarkable swimming powers, and their wandering habits, which carry them over broad expanses of the seas in which they live, it is probable that but little can be done toward the material reduction of their numbers. A school marauding on the coast one week may be far away the next and its place may be occupied by another host that has come from an unknown distance in the open sea. If they can not be exterminated, the only economic solution of the problem which they present is that they should be utilized and the curse of their presence converted into a blessing. This can be done only in accord with sound economic principles. A bounty, aside from other objectionable features, merely distributes the loss and can have no other effect. It acts like a system of fire insurance with no provision for preventing fires or minimizing their destructiveness. The loss still exists, but its burden is borne by a large number of persons.

"Leaving out of consideration certain secondary or subsidiary uses, principally of waste parts, fishes are economically utilized for fertilizer and for food. For the first purpose they must be cheap as compared with other species which are abundant, in fairly regular supply, easily caught, and easily handled. If the dogfish be economically available for the manufacture of fertilizer it will be utilized by factories privately owned and always on the watch for a supply of suitable and cheap raw material. There is no doubt that fertilizer of good quality can be produced from dogfish, the only questions being whether the fish can be obtained at a price low enough to show a profit on operations. If they can not be profitably used by private works there is no reason to suppose that they can be by those under Government control.

"The value of the fish will be governed competitively with other fishes and if the price be arbitrarily fixed too low the fishermen will not supply the fish, and if too high as in bills proposed for the establishment of Government reduction works, there will be an operating loss and the excess price of raw material will be in effect a bounty to the fishermen.

"None but the cheapest fish will be used for fertilizer, and, considering the heavy wear and tear on gear involved in taking dogfish, it is doubtful if they can be taken profitably except for food, and that appears to be the only means by which they may be converted into an economic product. That they are not at present eaten in the United States is no justification for the belief that they can not be introduced into the national diet. There are numerous instances of despised fishes and other aquatic animals attaining high favor after their qualities became known. Within a comparatively recent time the sturgeon, especially in the Great Lakes, was regarded as a nuisance and ruthlessly destroyed, but to-day a single large female fish may sell for as much as $150. The silver hake of the New England coast was formerly wholly unutilized, but is gradually coming into the markets; the catfishes are becoming high-priced fishes, and frogs are regarded as a delicacy, and the subject of frog farms is exciting interest as a source of profit. Instances might be multiplied.

"The failure to eat dogfish in the United States appears to be due to prejudice against them rather than to any lack of nutritiousness of palatability. There are two species of dogfishes on the Atlantic coast, the spined or horned dogfish, which has the more northern range, and the smooth dogfish, which is generally more abundant south of Cape Cod. These differ somewhat in the character of their flesh, the spined species being more oily and resembling in composition the medium grades of salmon. This fish is well suited for canning. The smooth dogfish is drier and when used fresh its flavor and qualities have been likened to those of halibut and swordfish. Neither of these fish has objectionable or unclean feeding habits, one feeding on organisms similar to jelly fishes and possibly on true fishes, and the other on crabs, starfish, and other bottom-dwelling animals. Both, so far as food is concerned, resemble other fishes highly esteemed on the table. Their flesh is white, and in external appearance they are not repulsive; their skins secrete little mucus and they never look slimy, like cod and haddock, when massed in the holds of vessels. They are eaten extensively in various parts of Europe. In Norway and Sweden they are used both fresh and salted or dried. In England, where there was formerly the same prejudice existing as in the United States, the spined dogfish has emerged from its odium and is gradually assuming a position of importance as a food fish, about five and one-half million pounds being used in 1912. In the fried-fish shops it masquerades and is readily eaten as Plaice, one of the most popular of English fishes, thus demonstrating that the elimination of prejudice against it is a prime factor in its introduction into consumption.

"Certain secondary products of the dogfish could probably find a market if the value of its flesh could be established. The liver is rich in oil, having most of the qualities of cod-liver oil; its skin makes an attractive leather, and is unsurpassed abrasive for fine wood and ivory workers, and the fins are rich in gelatine. All of these utilities should be convertible into profit and if they can be availed of on a commercial scale the dogfish problem could be solved to the satisfaction of both fishermen and the consuming public, and a heavy annual industrial loss would be converted into a profit.

"This bill is intended to provide authority and means for the attempted attainment of these ends by inducing the consumer to recognize the qualities of the dogfish and other waste fishery products and in educating the fishermen to prepare them and market them in such manner as will conduce to that result. It is a practical measure, and it is believed that it will yield practical results.

"While the dogfish is the most destructive probably of all the predacious fishes, yet the depredations that are wrought by other predacious fishes and aquatic animals is of itself a serious menace to our fisheries, and this bill will be of advantage to all the Coast and Gulf States."

The Senate Committee on Fisheries also held full hearings, but the proceedings were not recorded. This committee amended the bill and the Senate and House of Representatives passed the amended measure as follows:

An Act To conduct investigations and experiments for ameliorating the damage wrought to the fisheries by predacious fishes and aquatic animals.

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled*, That the Commissioner of Fisheries be, and he is hereby, authorized and directed to conduct investigations and experiments for the purpose of ameliorating the damage wrought to the fisheries by dogfish and other predacious fishes and aquatic animals.

SEC. 2. That the said investigations and experiments shall be such as to develop the best and cheapest means of taking such fishes and aquatic animals, of utilizing them for economic purposes, especially for food and to encourage the establishment of fisheries and markets for them.

SEC. 3. That the sum of $25,000, or so much thereof as may be necessary, is hereby appropriated, out of any money in the Treasury not otherwise appropriated, to enable the Commissioner of Fisheries to carry out the provisions of this Act, the same to be immediately available.

Approved, June 21, 1916.

This act withheld from the Commissioner of Fisheries certain authority conferred by the second section of the original draft which was regarded as important for the efficient performance of the duties imposed, and to the omission of which from a previous bill the Commissioner had called attention in his letter of February 5, 1915, previously quoted. The demand for some action to alleviate the dogfish nuisance was so urgent, and as the measure appeared to be the best obtainable, its approval was recommended and the plans already formulated were modified to meet the new conditions.

The Bureau of Fisheries had long before found that fresh dogfish were excellent food, and had had them placed on the market in limited quantities in connection with its campaign for the introduction of the tilefish. It was found, however, that like certain other food fishes, they could not be shipped far from the coast without deterioration. In order that the work should be most effective, it was necessary to find a sale for large quantities of the fish, and that the market should be almost country-wide. The most feasible plan, therefore, was to present them to the public in a canned condition.

In anticipation of the passage of an act granting the necessary authority to proceed with the undertaking as originally planned, the Bureau, about December 1, 1915, had had a small quantity of dogfish canned by one of the largest and most experienced packers of New England. The product was excellent in appearance and flavor, and was favorably reported on by the various persons to whom it was distributed for trial. Samples were tasted by some of the members of the committees of the Senate and House of Representatives during the hearings previously referred to, and no adverse criticism was offered. It was assumed, therefore, that the product was of a quality to warrant an attempt to place it on the market, especially as it could be sold at a very low price, a desideratum already strongly appealing to those interested in combatting the increasing cost of foods.

The original plan was to have these fish packed at the expense of the Bureau of Fisheries and to sell them to distributors at cost, with an understanding that the Bureau was to undertake a publicity campaign to promote their sale, and to accept the return of and make reimbursement for such of the product as for any reason might prove unsalable. This proposed procedure appeared to be direct and businesslike, as the Bureau would maintain control over distribution, could confine its campaign to the most favorable localities, would be in direct touch with such difficulties as might arise, and could take immediate steps to curtail losses. As the authority to buy and sell was not conferred by the law, and as the amendment of the bill originally submitted indicated that Congress was averse to granting such authority, it was necessary to proceed otherwise.

This legislation *was not sought by the Department, and it was not passed in the form suggested by the Commissioner of Fisheries* to the Committee on Merchant Marine and Fisheries to meet a situation which had confronted that committee for many years, but it appeared to permit a workable plan for meeting the conditions which the Bureau of Fisheries proceeded at once to put into execution.

Arrangements were made with the canners who had prepared the experimental pack to can 5,000 cases of 24 one-pound cans each, which were to be handled by them in the ordinary course of their business and sold at the lowest price consistent with a reasonable profit. The Bureau of Fisheries, on its part, undertook a publicity campaign to establish a market for the new commodity and authorized the packers to place on their labels a statement to the effect that the fish were packed at the request of the Bureau of Fisheries and according to a method approved by it. The name dogfish, lacking precision on account of its application to a number of distinct and widely varying species of fishes, and having acquired an approbrious implication on account of the destructive habits of the species, was changed to "grayfish" (gray being the natural color of the fish), and the packers were authorized to use that name on their labels. All of these arrangements and understandings were informal.

During the last quarter of 1916 the pack agreed on was ready and the Bureau of Fisheries launched its campaign. The packers were furnished with placards recommending grayfish which they were requested to send to their customers and the latter were furnished directly by the Bureau with circulars containing recipes which they were urged to place in the hands of consumers. Simultaneously the public press, household journals, and other agencies of publicity were provided with reading matter and news notes which were widely published. This marketing campaign was successful beyond expectation, the original pack was soon exhausted, and inquiries began to be received as to sources of supply and complaints because the demand could not be satisfied. The grayfish had left the shore waters of the Atlantic coast and the pack in New England could not be increased, but agents of the Bureau were sent to the Pacific coast and arrangements for a pack were made with several experienced canners in Washington.

The reports received by the Bureau of Fisheries from consumers, experts in dietetics, and others were at first all favorable and often highly commendatory of the quality and low price of grayfish. This continued several months, during which a large quantity of the food found a market with success. About July, 1917, a complaint was received that some of the fish canned by a Pacific coast packer gave forth a strong odor of ammonia, and this was followed by others of similar tenor. It was known that the grayfish developed this odor when stale, and it was at first assumed that some of the fish had been kept too long before being dressed and packed. The company whose pack had been complained of was first warned to be more careful and later was ordered to cease using the name of the Bureau of Fisheries on its labels.

Suspicion having been excited by these complaints, further investigation was made and it was found that even when perfectly fresh grayfish are packed by the best methods employed in canning other fish, such as salmon, there is a gradual evolution of ammonia in the cans, which, while not inimical to health, is objectionable to the sense of smell. There also develops, more slowly, a progressive deterioration of the cans which eventually causes minute perforations and gradually darkens the contents through the deposit of tin and iron salts in the fish, rendering them totally unfit for food.

Detinning of the cans occurs to some extent in a large number of canned products, but in most cases to but a small extent. It is particularly troublesome in certain vegetable products, and considerable losses have resulted, but in the common food fishes the reaction is not excessive and the difficulties in canning usually have not been with the keeping qualities but in the first preparation. In some cases, the tuna for instance, many thousands of dollars have been expended and much time has passed before a satisfactory product has been prepared and established on the markets.

Neither the Bureau of Fisheries nor the several experienced fish packers who canned grayfish anticipated these difficulties, as it was expected that when once palatably prepared and thoroughly processed and sealed the product would behave like other canned fish. It is easy to see now why this was not the case, but it was no more surprising that unexpected technical difficulties should be encountered in this case than were experienced in the early history of the canning of crab meat and shrimp and even lobster, entire packs of which spoiled to the heavy cost of the packers, as is well known. Such experiences are common when making new products.

The mistake in the case of the grayfish was an overeagerness to get results in order that the fishermen quickly should obtain the benefits intended by Congress in passing the act and that the food supply of the country might be enhanced in a time of urgent need. It is apparent now that the canned fish should have been held for at least a year to test its keeping qualities before effort was made to enlist the interests of the packers and involve them in the possibility of loss.

Between 1,200,000 and 1,500,000 cans of grayfish were packed before the difficulties described were recognized, and apparently over half of this quantity was consumed before deterioration. The remainder was left unsalable in the hands of the packers, jobbers, and dealers. If the original plan of action had been followed, and the fish had been packed at the expense of and sold by the Department, these unsalable goods which by limitation of the appropriation would have been smaller in quantity, would have been taken off the hands of the holders and the money refunded, the usual business procedure in such cases.

As it appears that the Department's moral obligation in the premises was not altered by the changes in plan consequent on the terms of the act of June 21, 1916, I transmitted to Congress an estimate for the sum of $45,000 to reimburse losses sustained by packers who had cooperated in the undertaking. I submitted the following explanatory letters with the estimate, my letter to the Secretary of the Treasury, dated January 23, 1919, reading as follows:

> There is transmitted herewith for submission to the Congress an estimate of appropriation in the sum of $45,000, to reimburse fish packers for losses sustained in cooperating with the Bureau of Fisheries in the canning and marketing of grayfish. Also a letter from the Commissioner of Fisheries in support of submission of the estimate.

Having given careful consideration to the matter and feeling with the commissioner, that there is at least a moral obligation resting on the Government to reimburse those who in cooperation with the department in this enterprise have suffered financial loss, I recommend the submission of the estimate at this time and its consideration in connection with the sundry civil bill.

Letter from the Commissioner of Fisheries to me, dated January 22, 1919:

There is transmitted herewith, with the recommendation that it be submitted to Congress, an estimate in the sum of $45,000 for inclusion in the estimates for "Expenses, Bureau of Fisheries, 1920."

An act approved June 21, 1916, appropriated $25,000 for alleviating losses sustained by the fisheries from the acts of predaceous marine animals, especially the grayfish or dogfish, and provided for a campaign to convert such animals to economic uses, particularly as human food. This measure was based on one suggested by the department as a substitute for a proposal made by certain representatives of the fishermen, which was regarded as not only economically unsound but which would have involved heavy initial appropriations for reduction works and annual appropriations for operation. The project was thoroughly discussed at hearings of the Senate Committee on Fisheries and the House Committee on Merchant Marine and Fisheries, specimens of canned grayfish being presented and tested at both hearings.

Based on the authority granted by the bill as it passed the House, tentative plans had been made by the Bureau of Fisheries to have several thousand cases of grayfish canned with the purpose of selling them to dealers for a consumer's test, the proceeds of the transaction to be covered into the Treasury as "Miscellaneous receipts." The act as amended by the Senate and approved did not authorize this direct business transaction, and as a practical alternative arrangements were made with an experienced canner to pack 5,000 cases after a method which the preliminary experiments apparently had shown to be satisfactory. The packer was to handle the product in the regular course of his business, but he was to be permitted to state on his label that it was recommended by the Bureau of Fisheries, and was packed at its request by a process approved by it. The bureau was also to undertake a publicity campaign to acquaint the consumer with its qualities and availability.

The original quality of the canned grayfish was excellent, as was attested by culinary experts to whom it was submitted for test, and by the ordinary consumer, and this in combination with its low price and its effective exploitation created a demand which the original pack could not satisfy. To meet this demand, arrangements, similar to those described, were made with competent and experienced fish packers on the Pacific coast in January, 1917.

In July, 1917, complaints began to be received in regard to an ammoniacal odor of the contents of some of the cans. At first it was believed that this was the result of carelessness in packing or the use of stale fish, but further investigation has shown that this odor develops normally in fish when canned according to the original method, and that, furthermore, there is a progressive detinning of the interior of the cans so packed, resulting in the absorption of metallic tin by the fish which renders it in time unsuitable for food. The product in which these effects occur was canned by essentially the same method employed with salmon and the difference in keeping qualities is due to inherent differences in the character of the fish which neither experienced canners nor the Bureau of Fisheries nor the expert physiological chemists consulted by the latter had reason to believe would result in these unfortunate reactions. The defect was not noticed in the first lot of fish packed because they were so promptly consumed, but later when the relation between supply and demand was in better equilibrium, and the goods, like other canned products, remained for six months or more on the shelves of dealers a serious situation developed; the grayfish canned by this method began to be condemned as unfit for food and the packers received many claims for reimbursement on account of spoilage and numerous complaints were received by the Bureau of Fisheries.

The bureau recognizes that there is properly lying against it no legally enforceable financial responsibility in this matter, but I am convinced that there is a moral obligation that it should not subject to serious loss those whose cooperated with it in an effort to introduce this commodity and those who purchased it on the recommendation made respecting it, and I earnestly recommend that the appropriation asked for the relief of these persons be granted. They entered into the transaction in good faith and with reliance on the recommendations officially made to them. They would have made little or no profit on the venture even if this product had not undergone deterioration as representations were made to them that in order to introduce it the selling price should be but slightly above the cost of production. If the Bureau had followed the original plan to have fish canned for its account and the product had been sold to distributors with the usual implied guaranty of keeping qualities, there would have been a direct obligation to make refund for spoilage. That a somewhat different procedure was followed should not be used as an excuse for evading this obligation.

Although the canning of grayfish by this original method has been in part unsuccessful, the original appropriation of $25,000 has been very productive. Other methods of canning grayfish with better keeping qualities have been devised, and the new product has been on the market for a year without complaint. The same fish is being sold in considerable quantities smoked, and is now regularly on the markets in a fresh state in New York, Boston, Seattle, San Francisco, and other places. The fund has been used, also, in exploiting various other neglected or little used fishes, with the result that over 15,000,000 pounds of certain hitherto neglected fishes, valued at about $1,000,000, were marketed during the present season, in addition to unknown but considerable quantities of a number of other species, concerning which quantitative data are not available. Most of this will result in permanent annual addition to the food supply, which undoubtedly will grow under the impetus imparted to these specific fisheries.

The above statement has been unofficially placed before the chairman of the House Committee on Merchant Marine and Fisheries, and the course suggested has his personal approval.

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SUPPLEMENTAL ESTIMATE OF APPROPRIATIONS REQUIRED FOR THE SERVICE OF THE FISCAL YEAR ENDING JUNE 30, 1920, BY THE DEPARTMENT OF COMMERCE, BUREAU OF FISHERIES.

Miscellaneous expenses, Bureau of Fisheries:

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| To reimburse fish packers for losses sustained in cooperating with the Bureau of Fisheries in the canning and marketing of grayfish, to be expended under regulations to be prescribed by the Secretary of Commerce, to be immediately available (act June 21, 1916, vol. 39, p. 232, sec. 1), submitted | $45,000 |

The appropriation was urged by the Commissioner of Fisheries and Deputy Commissioner of Fisheries and myself at hearings before the Committee on Appropriations, but was not allowed. On May 19, 1919, this recommendation was repeated and $15,000 additional requested; this also was refused.

At the present time two companies on the Pacific coast are producing, monthly, about 70 tons of stock and poultry feed from grayfish, and kippering the fish for human consumption, which was suspended during the summer, is about to be resumed. This latter product is placed on the market both fresh and canned.

Through some complete misunderstanding this grayfish work has been confounded in discussions in Congress with a series of demonstrations in fish cookery, anothe- undertaking in which this Department engaged through the Bureau of Fisheries. The two had no relation to one another. The grayfish project dealt with the commercial preparation of a particular fish for the market, and the establishment of a fishery for it. The cooking demonstrations were for the purpose of instructing cooks and housekeepers in the best and most economical methods of preparing *all kinds* of fish for the table, particular attention being devoted to the cheaper varieties available in each locality but which are not adequately utilized because their merits and the proper methods of cooking them are not known to the public. In other words, one of these projects was a manufacturing and mercantile undertaking and the other was concerned solely with the home. The cookery demonstrations, furthermore, were more fortunate than the grayfish undertaking in that they were successful from the beginning, and were received with unalloyed satisfaction and thankfulness by all to whom they were directed. They were a direct and effective contribution to the welfare of the home, and not only aided in reducing living costs through the use of cheaper fish, and usually wasted parts of fishes, and more economical cooking materials, but they were contributions to health through the exposition of more wholesome methods of cooking.

This work was initiated as an emergency measure during the war under an allotment from the appropriation for national security and defense, but it was received with such general favor and had so conclusively demonstrated its value under existing economic conditions that Congress was asked for an appropriation of $15,000 for its continuance during the fiscal year ending June 30, 1920. The following correspondence relating to this request explains this work and what it accomplished:

DEPARTMENT OF COMMERCE,
OFFICE OF THE SECRETARY,
*Washington, June 7, 1919.*

MY DEAR MR. SECRETARY: There is herewith handed you for transmission to Congress an estimate of an appropriation in the sum of $15,000 for the conduction of demonstration and the imparting of instruction in cheap, wholesome, and correct methods of preparing fish for consumption and in cooking same for use as food.

The work thus far done of this kind has been under an allotment from the fund for the national security and defense. It has been fully appreciated by the public all over the country, and it is deemed of special importance in this time of high food prices that the work should be continued.

Yours, very truly,

WILLIAM C. REDFIELD,
*Secretary of Commerce.*

The SECRETARY OF THE TREASURY.

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DEPARTMENT OF COMMERCE,
BUREAU OF FISHERIES,
*Washington, June 6, 1919.*

There is transmitted herewith for submission to the Congress an estimate of appropriation in the sum of $15,000 to enable the Bureau of Fisheries to continue during the fiscal year 1920 demonstrations of the best and most economical ways of preparing and cooking fish. This work was inaugurated on the Pacific coast in May, 1918, and was made possible by virtue of an allotment for the increase of the food supply from the appropriation for national security and defense. It proved effective and successful beyond all expectations and was extended to a number of the larger communities in the Mississippi Valley and as far east as Boston and its vicinity. These demonstrations originally were regarded as war work and it was assumed that should the war continue the expenses incurred in their prosecution could be defrayed from appropriations similar to that under which it was inaugurated. It was not until the demonstrations had been extended to the Mississippi Valley, after the bureau's estimates for the next fiscal year had been submitted, that it was appreciated that they were of such extraordinary public value as to demand that they should be continued under peace conditions.

From every city in which the meetings have been held the bureau has received expressions of appreciation and commendation from chef associations, women's organizations, individual housekeepers, and the fish trade, and the quality of the service rendered has been further indicated by the extent and nature of the press notices, especially during the period since the signing of the armistice and after nearly two years of surfeit of food-conservation propaganda. The work is blazing a new trail in the field of domestic science, a fact which is attested by those most highly skilled in cookery as well as by the most humble housekeeper. After a demonstration attended by the chefs and stewards of the principal hotels of Chicago, the International Stewards' Association requested most urgently that a similar demonstration be given at the national convention of that organization. Innumerable housekeepers have informed the bureau and its agents that after pursuing the methods advocated they have been able cheaply to prepare fish in a manner acceptable to their households, which had before held fish in low esteem.

The work is directed principally toward the introduction of more wholesome and appetizing methods of cooking fish, the use of the cheaper and more abundant species in each locality, and the utilization for food purposes in the home of those parts of the fish usually thrown away. It is the bureau's most direct and effective contribution to the needs of the women of the country and the improvement of home and health. At this time, when the difficulties of the household are manifold, it is particularly important, and I urgently recommend that provision be made for its continuance.

H. M. SMITH, *Commissioner.*

The SECRETARY OF COMMERCE.

DEPARTMENT OF COMMERCE,
BUREAU OF FISHERIES,
*Washington, June 6, 1919.*

MEMORANDUM REGARDING DEMONSTRATIONS ON FISH COOKERY:

In one year we have given 125 demonstrations on fish cookery and directly reached some 15,000 women, and, as has repeatedly been shown, those attending have been so enthusiastic with our work that they have carried our message into many other homes. Meetings have been held on the Pacific coast, from Bellingham to San Diego, in the principal cities of the Middle West, and in Boston and vicinity.

The women have been taught a new way of cooking fish which eliminates 75 per cent of the labor and of the expensive cooking fats or oils, as well as most of the odors. The housewives all over the country are loud in their praise of finding an easy and inexpensive way of cooking fish, and particularly interested in finding all sorts of cheaper fish and fishery products of which they had never heard before. We have tried to show them how to get a dinner of fish for four persons at a cost of 25 cents, or two meals for 40 cents. In spite of the high prices ruling we have always been able to introduce them to cheaper varieties, procured from their own markets.

I find the housewife is much gratified to think her Government is taking enough interest in her problems to send us through the country teaching and preaching economy and showing her how to get two dinners for what she has been paying for one. She is keen to recognize, when it is pointed out to her, that at present there is not much hope for cheaper meats, poultry, eggs, or milk, and that she must look to fish for cheap protein food for her children's building materials.

I also use these meetings for the dissemination of helpful propaganda for the building up and holding together of the home. In these days of unrest, I try to calm down the women by suggestions for them to meditate over, pointing out that, with a country at war, the Government takes into consideration the morale of its soldiers, but with a nation at peace the morale of the country is in the hands of the wives and mothers; they are the hidden stones which hold up the whole edifice of civilization. The humblest little woman, toiling to serve her family a well-cooked meal, and looking well to the ways of her household, is setting an example in her community for which her Government will rise up and call her blessed, as well as her husband and children.

EVELENE SPENCER,
*Demonstrator in Fish Cookery.*

The recommendation failed to meet with the approval of the Committee on Appropriations, and when the bill carrying appropriations for the Bureau of Fisheries was being considered by the House of Representatives on June 21, 1919, the chairman of the Committee on Appropriations cited the dogfish case as a reason for not granting the item of $15,000 "for the conducting of demonstration and the imparting of instruction in cheap, wholesome, and correct methods of preparing fish for consumption and in cooking same for use as food." I brought this matter to the attention of the chairman in the following communication dated June 25, 1919:

My attention has been called to your remarks in connection with the omitted item of $15,000 for the demonstration and imparting of knowledge and instruction in the proper cooking of fish, appearing on page 1603 of the Congressional Record for June 21. The description I have used is neither yours nor mine, but it is sufficiently accurate to make the subject clear.

My purpose in writing you is merely to point out for your information and that of the Committee on Appropriations that there is no connection whatever between the item of $15,000 omitted and the item of $60,000 with respect to the grayfish, and also to advise that as regards this latter matter there are facts apparently not before you at the time.

The item of $15,000 has nothing whatever to do with any canned fish. No person concerned with it had any relation to or part in the matter of the grayfish, nor has any criticism ever arisen in connection with the matter for which the $15,000 was asked. The reverse is true. That work has been the means of putting on the market millions of pounds of new, unused foods and of greatly enlarging the use of foods now little used. Public expressions of gratitude and appreciation have come from many parts of the country. No word of fault has ever been found.

The matter of the grayfish refers solely to canned foods put up by canners themselves. It is as distinct and different from the other as day is from night. It refers to a past that has gone. To-day grayfish is being satisfactorily prepared for the market and is a regular article of food. The difficulties in connection with it are merely such as were normal to the initial stages of a new article and the problems have been satisfactorily solved.

The Department thereupon renewed its estimate for an appropriation for this work, and increased the amount required to $75,000. The representation of the matter to Congress was made the occasion for a full statement of the work already accomplished and crying need for its continuance in my letter to the Speaker of the House of Representatives, dated July 19, 1919, as follows:

> In respectfully asking the attention of the House of Representatives again to House document 88, Sixty-sixth Congress, first session, kindly let me say that the reason for so doing is the high price of food and the insistent, imperative demands which these high prices make upon the modest incomes of the poor.
>
> It is true that the estimate submitted under date of 7th June, and concerning which I had the privilege of writing on the 13th ultimo to the chairman of the Committee on Appropriations, has been considered both by that committee and by the Committee on Appropriations of the Senate and has by both been rejected. Nevertheless, I venture again to bring it before you because the demand for cheaper food is insistent and will not down; because the prices demanded for food are high and have little, if any, tendency to reduction; and because Congress has itself since the matter was brought up before expressed a keen interest in the subject of the excessive cost of living. Furthermore, it is my duty to insure that neither the department nor myself has failed to make clear to the thought of Congress that for a modest sum it is possible to continue a great and successful work in providing supplies of cheap, nourishing, and palatable food, and thus to assist in solving the problem which presses so severely upon every household. For these reasons it is earnestly requested, not so much on behalf of the Department of Commerce or the Bureau of Fisheries, as on behalf of the people of the United States, many of whom are oppressed with high prices, that this matter be given further consideration at the hands of the appropriate committee.
>
> The purpose of the fund of $15,000 which is now asked, is to conduct demonstrations and impart instructions in correct, cheap, wholesome methods of preparing and cooking fish for consumption. This work has been successfully carried on in the leading cities of the States of Washington, Oregon, and California; in St. Louis, Chicago, St. Paul, and Minneapolis; Cleveland and Cincinnati; Boston and Cambridge, Mass.; in St. Augustine, Key West, and three other cities in Florida; Savannah and Valdosta, Ga.; in connection with the Agricultural and Mechanical College of the State of Mississippi; and at Washington, D. C., itself. This work is now stopped; unless it can be resumed at an early date, the trained personnel who have done it will be lost.
>
> If there is question as to the necessity of this work, the answer is the price of food. If there is question as to whether the Government should do the work, the answer is that there is no other agency which is nation wide that can do it, and to use separate agencies for the purpose would be both expensive and impracticable. If the question of economy is raised, the answer is that by the services of four persons the whole country can be reached at an expense of $15,000, and one might ask in turn by what other means so great a result can be had for so little. If the question of urgency is raised, the answer is that the pressure of high prices is a living, hurtful fact which calls for every possible step showing hope of either improvement or remedy. Finally, if there is question as to the success of this work, the answer is that in every State in which meetings have been held voluntary expressions of appreciation of the usefulness and importance of the work have come from housewives, from women's clubs, from organizations for food conservation, from stewards' associations, from restaurant owners' associations, from hotel owners' associations, from chambers of commerce, from the heads of domestic science schools and colleges, and from the fishery trade. Voluntary letters commending the work have come from—
>
> San Francisco Center of the California Civic League.
> Twentieth Century Club, Berkeley, Calif.
> Director of food conservation for city and county of San Francisco, Calif.
> Community Service Organization, St. Louis, Mo.
> Home Demonstration Office, St. Louis, Mo.
> International Stewards' Association, Chicago, Ill.
>
> Again and again women have called attention to the fact that they had been using little or no fish food because of some groundless prejudice or because of ignorance, and have testified to the value of the meetings to them in teaching the value and excellence of properly cooked fish. Fifteen thousand women have received direct instruction and many thousand more have been indirectly but effectively reached.
>
> There is lack of appreciation of the food value of fishery products. There is ignorance of the relative merits of the different fish. There is failure to employ the best methods of preparing them for the table. For these reasons, there is a failure to utilize an abundant and available supply of aquatic foods, which are both wholesome and cheap. There was no need for cheap food during the war that does not now exist.

It can be by no means said with truth that an emergency existed which has passed away. The answer to such a suggestion is found in every household.

The demonstrations have emphasized the need of eating little-used or neglected products. Among those that have been demonstrated are the flounders, rockfishes, sable fish (Pacific black cod), sand dab, sharks, skates, sole, squid, whale, whiting, the milts and livers of salmon, and the roe and buck roe of various fishes. In the Middle West, however, special emphasis was laid upon the use of frozen fish, of which there were abnormally large stocks in the cold storages of the country.

The careful buying of fish has been taught and also the way of utilizing the head and trimmings, which parts are richer in flavor, but usually thrown away, as well as correct methods of cooking, insuring economy in the use, not of the food alone, but of the fats and oils, and saving time in both cooking and serving.

The Department of Commerce, through the Bureau of Fisheries, has been fortunate in the personnel employed upon this work, and particularly in obtaining the services of women able to combine with their demonstrations of how to live more cheaply in these trying times such teachings of domestic management as tend to build up and hold together the home. Housewives all over the country are loud in their praise of finding an easy and inexpensive way of cooking fish, and particularly at finding many kinds of cheap fish and fishery products of which they never heard. Our demonstrations have shown them how to get a dinner for four persons at a cost of 25 cents, or two meals for 40 cents, and in spite of the high prices ruling they have always been able to introduce cheaper varieties procured from the local markets in which the demonstrations were held. Literally, this is the work of showing how two dinners can be had for what has been the cost of one, and the lesson has been taught that while there is perhaps little immediate hope for marked reduction in the price of meat, poultry, eggs, or milk, there can be found in various kinds of fish now little used, or not used at all, cheap and sustaining food in abundance. A work of such profound benefit to our people, which so directly promotes the welfare of every home, ought not, in my judgment, to be set aside. I am convinced that the Bureau of Fisheries in tapping supplies of little-used or unused food has done a service which will outweigh manyfold the monetary value of the appropriation requested, and I am equally convinced that when the importance of this work is known and realized there will be but few voices raised save in its favor. It has been the most direct and effective contribution of the Bureau of Fisheries to the needs of the homes of the country and to the improvement of health and to removing the anxious cares which the price of living impose upon many of our people.

This subject came up incidentally on the floor of the House of Representatives, at which time mention was made that in connection with the introduction of certain fishery foods faults had been found, and that an estimate had been presented to make good certain claims believed by this department to be morally sound This is mentioned only to point out that the two subjects are neither the same nor are they alike. They originated in different branches of the Fishery Service. The one had to do with the preservation of canned goods by business houses who are packers of such goods; the other has to do only with domestic cooking. No argument from the one can bear upon the other. This is the more true that the faults in connection with the canned product were long since corrected and the product itself is now an established article of food.

Finally, may I suggest that if there be force in the statement that any group of producers do in any measure dominate the markets for food, here is a practical means of competition, opening a supply not dependent upon the will or the interest of any man or group of men, but found on every shore, in our lakes and streams. It can be had in many places for the taking if its value is made known and the people are taught its use. Let me conclude by quoting from the Fisheries Bulletin for March 1, a letter from a student in the San Diego (Calif.) High School:

"* * * I would like to say a few words of commendation and praise in regard to the wonderful work your representative, Mrs. Spencer, is doing here in our city. She is waking the women and girls up to see what their duty is to their country, themselves, and others.

"For two years I have done a goodly part of the family cooking, but I never had any realization of the nourishment in fish. I thought beef and other meats were the only animal foods of any value, but Mrs. Spencer has opened my eyes, and I intend to use a great deal of fish, and I feel sure that other people feel the same way.

"I received, though, a greater lesson from Mrs. Spencer's talks than the use and utilization of fish. She made it so plain that the young girl of America must become proficient in all the housewifely arts; that unless she does she will wreck not only her own life but the lives of her family. I think that this part of Mrs. Spencer's work is going to run deepest, and I sincerely hope she will 'drive it home' in every part of the United States, for the girls of America need to be educated out of the false conceptions they have of what a lady should be proficient in."

I may add also the following from a Chicago broker and wholesale dealer in fish: "I take pleasure in advising you that your Mr. H. L. Kelly and Mrs. Spencer did the fish industry a great benefit in their recent exhibition of cooking and serving fish in Chicago. Not only were the meetings a success but the amount of advertising given the fish industry through their efforts has had immediate effect upon the consumption of fish in Chicago. Mr. Kelly did everything possible to interest not only the fish dealers but also the stewards and chefs of the leading hotels in Chicago. Work of this kind tends to bring the fish prominently before not only the housewife but the patrons of hotels and restaurants, and tends to the general good of the fish business."

For the reasons above stated, I beg to renew my request that the matter be again considered.

The same fate befell this second effort of the Department to secure the support of Congress in a successful endeavor to reduce the cost of living, as a part of the general movement of the Government to that end. The unfavorable action was based on the same erroneous argument as in the first place, namely, that the Department was striving to get authority for a project similar to that undertaken with regard to the dogfish. The official judgment of Congress was pronounced as follows:

[Extract from remarks in the House of Representatives by Hon. J. W. Good, chairman of the Committee on Appropriations, Sept. 16, 1919, during consideration of the first deficiency appropriation bill (H. R. 9205). See Congressional Record, Sept. 16, 1919, p. 5869.]

Of the estimates submitted by the Department of Commerce for relief of the high cost of living, $75,000 was for the purpose of demonstration of methods of preparing and cooking fish. Congress has had some experience with this department on this *very same subject*. In the act approved June 21, 1916, the Department of Commerce was given $25,000 to conduct investigations and experiments with regard to dogfish. Out of that appropriation the department did make an investigation and demonstration in the matter of cooking and canning dogfish and gave the results of its investigation to the canners. A great many canners of fish canned dogfish in accordance with the instructions of this department. The result was not satisfactory. After these fish had been canned and disposed of the cans commenced to explode, and last year the Department of Commerce came before Congress with an estimate of $60,000 to reimburse these canners who had canned dogfish in accordance with the methods which had been demonstrated by the Department of Commerce.

A great many of these estimates for reducing the high cost of living are of the dogfish character and if granted would give just about as much relief as did the $25,000 previously appropriated for dogfish demonstrations. The people want relief from high prices, not dogfish demonstrations.

This more recent statement, like the former from the same source, contains important misstatements, omits essential facts in regard to the dogfish work, and wholly ignores the main issue. A partial and temporary failure in a pioneer effort that was deliberately curtailed by Congress is used as an argument against a wholly different piece of work that has proved highly successful.

The assumption of a moral obligation to reimburse canners to the amount of $45,000 or $60,000 for losses incurred in an effort originating with Congress itself to mitigate a great public nuisance may be a highly reprehensible act for which this Department should be held up for criticism and blame. The other side of the balance sheet, however, should be considered. It should be remembered that, as an alternative to the course recommended by the Department, there was pending in Congress and strongly backed a proposition that the Government should go into the business of manufacturing fertilizer from sharks and should pay a bounty on sharks, and that there should be built and operated as many as 100 fertilizer plants which were avowedly to be maintained at a large annual loss. For a period of five years the amount of money required to carry out the terms of the proposed legislation would have been not less than $20,000,000, and at the end of that time the Government would have had on its hands some expensive plants of no further usefulness, and the permanent abundance of dogfishes would have been affected no more than by a debate in Congress.

This Department has with justice opposed measures which involved the possibility of such inroads on the Treasury and prevented, at least temporarily, any further efforts in the same direction. It has been prevented, on grounds wholly unrelated to the subject, from continuing a successful, cheap, and efficient work of adding to our food supply in a time of need.

# REPORTS

OF THE

# DEPARTMENT OF COMMERCE

BUREAU OF FOREIGN AND DOMESTIC COMMERCE
BUREAU OF STANDARDS
BUREAU OF THE CENSUS
BUREAU OF FISHERIES
BUREAU OF LIGHTHOUSES
COAST AND GEODETIC SURVEY
STEAMBOAT-INSPECTION SERVICE
BUREAU OF NAVIGATION
APPOINTMENT DIVISION
DIVISION OF PUBLICATIONS

# REPORT

OF THE

# DIRECTOR, BUREAU OF FOREIGN AND DOMESTIC COMMERCE

# REPORT

OF THE

# DIRECTOR, BUREAU OF FOREIGN AND DOMESTIC COMMERCE.

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Department of Commerce,
Bureau of Foreign and Domestic Commerce,
*Washington, August 15, 1919.*

Sir: I have the honor to transmit, as Director of the Bureau of Foreign and Domestic Commerce, the annual report of the Bureau for the year ending June 30, 1919. Burwell S. Cutler, who resigned on July 19, 1919, was the Director of the Bureau for the period covered, and therefore deserves credit for the work accomplished as detailed in the following report.

The portions of this report covering the activities of the several divisions and branches of the service have been prepared in such a manner as to indicate the status of events on June 30, 1919, the end of the fiscal year.

## REVIEW OF THE YEAR'S FOREIGN COMMERCE.

The transition from war to peace is clearly reflected in the trade movement. The exports of American products increased in value $1,200,000,000 for the year ending June 30, 1919, but of this gain only $200,000,000 came during the six months from July to December, 1918, while more than $1,000,000,000 increase was recorded during the first six months of 1919. The gradual character of the changes is brought out more clearly by dividing the fiscal year into four-month periods. The increase during the first four months (July–October) was $200,000,000, during the next four months (November–February) $300,000,000, and during the last four months (March–June) $700,000,000. In other words, during eight months there was a gain of only $500,000,000, while during the last four months there was a gain of $700,000,000.

These figures understate the real improvement, for the increased upward movement of American goods was achieved in the face of a decline of some $600,000,000 in war supplies. Explosives alone declined more than a quarter of a billion dollars, while decreased shipments of copper, brass, steel billets and ingots, firearms, and picric acid accounted for the rest of the decline. Commercial shipments, therefore, really increased nearly $1,800,000,000 during the year.

The great increase in the year's trade is found in foods and raw materials, not manufactured articles. Meats (including lard), wheat, and cotton alone account for a billion dollars' gain. This movement reflects the most pressing need of European countries.

Among the manufactured articles there was little change in the aggregate. Partly manufactured goods fell off $200,000,000, while finished manufactures increased by a like amount. The decline in semimanufactured goods came in the class of war materials, such as copper, brass, steel billets, and picric acid. The only important gain was registered by leather. Among the fully manufactured articles, the striking loss in explosives and firearms just about balances the gain in machinery, cotton manufactures, mineral oils, paper, and electrical appliances—and it is to be noted that it took six classes of peace articles to balance only two classes of war supplies. The net gain of $200,000,000 in this class is registered by numerous articles, no one of which showed an increase of more than $15,000,000. This uniform moderate increase of our finished manufactured exports all along the line is a most encouraging sign that our foreign trade is resuming normal lines.

There was a large gain in our exports to Japan and China, to South America, and to Australia. The increase to Japan (mostly raw cotton) and China is slightly greater than the increase to South America. But these gains, while substantial, are dwarfed by the enormous increase in our shipments to northwestern Europe. Belgium shows the largest increase of all. It, together with the United Kingdom, France, the Netherlands, and the three Scandinavian countries, showed an aggregate gain of $1,800,000,000—a 60 per cent increase over the fiscal year 1918.

It is easy to magnify or to minimize unduly the real significance of our trade gains. When the armistice was signed, stocks of goods were depleted in practically all foreign countries, so that there was immediate need of imports which the United States was in a position to furnish. European countries have not yet been able to offer any strong competition. Moreover, the value tends to give an exaggerated idea of the actual increase because of the world-wide rise in prices. The observer who ignores the changing value of the dollar and leaves out of consideration the unusual demand and the lack of competition may conclude that the gain is much more substantial than it really is. On the other hand, there is no lack of writers who argue that the whole apparent gain is illusory. A study of the quantities, so far as recorded statistically, convinces them that there has been no material gain in the tonnage of outbound cargoes. They emphasize the peculiar advantages that have been enjoyed by our exporters without allowing for the serious difficulties that have had to be overcome. Our trade has unquestionably been retarded by lack of shipping, by the trade restrictions that still persist, and, above all, by inadequate means of financing trade, since many would-be customers have not yet products to offer in exchange.

The real situation is midway betwen these two extremes. Advancing prices have much to do with the increased value recorded. So far as can be ascertained from the export statistics, the quantity of outbound goods was little, if any, larger in the fiscal year 1919 than in the fiscal year 1918; but this fact does not mean that the gain in value was due solely to an advance in prices. It is due much more to a change in the class of goods exported. We shipped 4,500,000 tons less of coal last year, but we shipped 5,000,000 tons more of wheat and cotton and meat and miscellaneous goods. Advancing prices have unquestionably done their part in raising the value of our exports, but the substitution of a higher class of goods for coal is a no less important factor. Moreover, our exporters have enjoyed exceptional advantages in trade building, but their efforts have, nevertheless, been hampered by the unusual difficulties resulting from the long war.

The trade balance of the last year is stupendous, exceeding for the first time in our history $4,000,000,000. It comes, moreover, after a series of years in which the excess of exports attained unprecedented heights. The effect is, therefore, cumulative. We have been accustomed to regard a large excess of exports as a peculiarly favorable feature. It has now grown out of bounds, and by its magnitude presents a serious problem and threatens the growth, perhaps even the maintenance, of our foreign trade.

There is no question about the demand for American goods abroad. Europe is still experiencing an acute lack of food, raw materials, and all kinds of manufactured goods. The present problem is to find means of paying for the goods exported until foreign production is more fully restored. The pertinent question is the extent to which we can safely take future promises to pay.

The problem of credit to even the strongest nations is difficult until the peace settlement is concluded. Whatever one's views about the proper nature of the peace settlement, all may readily see and agree that foreign credit arrangements are being delayed until a peace settlement assures stabilized conditions. Without adequate provisions for foreign credits there can be no remedy for the exchange situation, which is automatically increasing prices that foreign purchasers have to pay for American goods. With foreign currencies depreciated as they are to-day, old-established American business houses abroad are finding in certain cases that they are confronted with lower prices from competing countries.

## IMPROVED TRADE STATISTICS.

The experience of the last few years has brought to the front as never before the need for adequate statistics of foreign trade. The returns must be full, accurate, and timely, and they must be presented so as to bring out clearly their trade significance.

The Bureau is doing its utmost to meet this need. During the last fiscal year it sought and obtained from Congress authority to issue its annual returns hereafter for the calendar year instead of for the fiscal year. The first annual report on the new basis is now in press and gives complete details by articles and countries of the foreign trade for the calendar year 1918 and separately for the last six months of that year. The six-month figures will not merely be of use to connect the statistics of the fiscal years heretofore published with the new calendar year returns, but will furnish the means for detailed study of the entire war period, which may be taken to cover the four and a half years from July 1, 1914, to December 31, 1918. The change to the calendar year will unquestionably prove helpful to business houses, which, as a rule, make up their accounts by calendar years. It will also facilitate comparison with the production figures collected by the census and with the trade statistics published by foreign countries.

Much time has been spent in collaboration with other Government offices in working out a classification of commodities that will correspond to present-day commercial usage and give details for many important commodities that are not now returned separately. Limitations in equipment and clerical force make it impossible to show separately all of the commodities desired by exporters and manufacturers, but the Bureau has gone as far as possible to comply with their wishes. The work has been performed mainly by G. B. Roorbach, of the Shipping Board, acting as chairman of an interdepartmental committee designated by the Secretary of Commerce. Without the collaboration of the Shipping Board and other Government offices it would have been impossible to make a thorough canvass of the situation.

There are frequent complaints that our import and export statistics are unduly belated. The Bureau realizes fully the importance of up-to-date figures, but it is impossible to publish promptly the detailed figures required without a large increase in the statistical force. In Great Britain the monthly returns are published within about 10 days after the close of the month. But this result is made possible only by excluding from the accounts of the month all returns that reach the central office after the close of the month and by utilizing during the first few days of each month a large force of compilers otherwise employed during the remainder of the month.

Important as it is to show promptly detailed returns of imports and exports, it is no less essential to provide means for accurately analyzing the statistics. The figures in themselves often fail to carry their lesson. It is only by elaborate study of trade and industrial conditions throughout the world that the teachings of the figures can be learned. A great deal of light is thrown on trade movements in the United States by comparing the statistics systematically and thoroughly with the statistics of other countries.

## LINES OF TRADE ADJUSTMENT.

The war has seriously checked normal production in Europe and at the same time has decreased the ability of European nations to pay for imported goods. The United States can ship greater quantities of goods abroad than ever before if some kind of reliable payment can be obtained either in the form of imports or of sound promises for deferred payment. It should be recognized that, in the long run, larger exports are dependent upon larger imports, both because this provides for settling the international account and because both-way cargo is essential for low freight rates. International trade, to be lasting, must be in both directions. As long as European production is held back and the United States stands as the world's principal producer, the situation will be unnatural. It can not go on indefinitely. The best argument for the extension of loans to European countries is that this will enable them to fully restore their production, and thereby prepare the way for a normal profitable exchange of goods. We would have a right to expect that these credits would be used for the most productive purposes, that industry in these foreign countries would settle down to steady work, and, moreover, that there would be no question as to the serious obligation to make payment when due. The basic test of a credit risk is character. The prospect of these foreign loans may be viewed hopefully because of the confidence that may be reposed in the character and integrity of the great nations with which we have been associated.

At such time as the international situation is sufficiently stabilized to justify the making of comprehensive plans for credits, American bankers will have to be prepared to offer to American investors over $4,000,000,000 in foreign bonds during the first year. The extent to which our export trade may be increased beyond its present size will depend upon the amount of loans exceeding four billions a year that American investors can be induced to subscribe for. Generally speaking, American investors are not familiar with foreign investments. A nation-wide campaign will be necessary to educate investors as to foreign business conditions.

During the period when the international credit situation is being adjusted, American exporters will not know definitely what they can count on. There are, however, good grounds for feeling sanguine that credits can be so handled as to enable Europe to restore its industry and at the same time provide an outlet for American exports.

The new international position of the United States is not a passing phase. Year after year should see a large volume of foreign investment and a steady increase in American exports. New York will take on the international business character that has been typical of London.

The significant thing for American bankers and exporters to realize is that they will have to prepare their organizations for a large and continuous foreign business. Notwithstanding all that has been done in the past four years, we are to-day only at the beginning of an accurate knowledge of foreign business and have only a limited number of men trained and experienced in the foreign field. At present, we are largely in the position of beginners. As time goes on success will be limited more and more to the trained and efficient. The sudden arrival of the United States at a position of great opportunity in foreign business, however, necessitates generally an intensive study of export methods.

The situation would not be so difficult if opportunity had come at a time when conditions were stable. To-day, however, the trade of the world is in a state of constant flux. The most recent information is essential as a basis for dependable policy.

There is now an emergency demand for reliable data on foreign trade. The Bureau of Foreign and Domestic Commerce has a great opportunity for useful service. It is making a sincere effort to do all it can with its present facilities.

## POSITION OF THE BUREAU.

The period from July 1 to the signing of the armistice on November 11 found the employees of the Bureau largely concerned with war activity. A reading of the sections of this report devoted to the work of the different divisions and of the offices abroad will show the important way in which the service of the Bureau was useful during the war. Wherever there was essential work to be done which the Bureau, because of its experience and facilities, was equipped to do, this work was undertaken at the instance of whatever Department happened to need it. The constant service of the Bureau to the different war organizations was valuable in keeping the Bureau's staff intimately informed as to conditions in war trade, and at the same time it made possible prompt and expert attention to demands which otherwise would not have been so adequately satisfied.

After the signing of the armistice, the Bureau immediately began to make plans looking to the resumption of normal trade. Special investigators were sent to Europe to work under the direction of commercial attachés in studying the readjustments in industry and commerce made necessary by the results of the war. The information gathered was especially valuable in assisting American business men who went to Europe in large numbers for the purpose of restarting business already established or opening new business. During the unsettled times existing, this Government service to American firms was especially appreciated.

Because of the rapid change in conditions, it appeared important to have a greater interchange among Bureau officials than was customary. A number of the principal members of the staff in Washington who had been in close touch with American business during the war were dispatched to European posts where they could view conditions in the light of the existing American situation. Other men who had had experience in different parts of Europe were brought back to the United States to confer with American business men and to have a part in the administration of the Bureau. It is thought that for some time it will be necessary to have a considerable moving back and forth in order that the whole service may be as alert as possible to conditions both at home and abroad. A great difficulty in bringing back men from abroad to the United States is that the statutory positions carry such low salaries that it is a considerable sacrifice for experienced men to take them. It has been only through the public spirit manifested by some of the men of widest experience in the Bureau's service that it has been possible to fill some of the positions in the United States with men of this character. The Bureau should be enabled in the future to have a certain number of positions in the United States sufficiently well paid to make it possible to fill them with men who have a wide practical experience in the foreign field.

The service has been seriously embarrassed because of the restriction which makes it impossible to assign more than one clerk to each commercial attaché or to pay such clerks a salary exceeding $1,500. Clerks that are sent to commercial attaché offices abroad must be competent stenographers and office men and, at the same time, must be familiar with a modern language. Further, it is desired to select men who have sufficient education and training so that they may be capable of profiting through their experience and become available for more important positions. The fact that it is not possible to increase salaries of clerks who have rendered several years of satisfactory service means that these men leave us and we lose the benefit of their experience. If it were not for the fact that trade commissioners working in general cooperation with commercial attachés are able to assume important duties, the situation would be serious. As it is, the position will be very embarrassing until this restriction is removed.

The growth of the Bureau's service is shown by the fact that in 1913 there were only 12 persons in its field service, whereas the number in the field service on June 30, 1919, was 159. The increase in the total staff of the Bureau, which includes the field force, the staff in Washington, and the employees in the district offices, increased from 100 in 1913 to 370 on June 30, 1919. It is obvious that the field force has increased much more rapidly than the central force in the United States. Furthermore, the Bureau receives reports from the American consular service, which reports, during the past few years, have very greatly increased in number and importance on account of the growing effectiveness of the consular service in commercial matters. Altogether, a very great strain has been placed upon the staff at Washington and in the district offices to distribute the commercial information which comes from abroad. In order that the results of the work of the field force may be made most effective, it is essential that provision should be made for increasing the staff in Washington and in the district offices. One of the most serious aspects of this question occurs in the Editorial Division. Before reports from foreign representatives are given to the printer they are carefully edited to make sure of their accuracy and to ascertain whether they meet the needs of the American business public. This requires slow and painstaking work. It is very unfortunate that the reports to be edited have accumulated so rapidly that it has been impossible to get them out at as early a date as is desirable. At the present time, when foreign conditions are changing so swiftly, it is disastrous to have delay in making these reports available to American business men.

The Bureau of Foreign and Domestic Commerce in its present form has virtually existed since 1912. There are in several divisions men who have been in the service for many years. As a whole, however, the bulk of the Bureau's staff has been built up since 1912. There has been a great growth in efficiency from year to year on account of continuous service and experience. To obtain the best results, it is essential that adequate means should be provided to retain in continuous service men who have done effective work.

## QUALITY OF SERVICE.

The Bureau of Foreign and Domestic Commerce is the agency designated by law to promote the foreign commerce of the United States. It does so by distributing to American business men information received from its own field force and from the consular service. It is a specialized Bureau devoted to a single aim—that is, the promotion of American trade abroad. Through close contact with commercial organizations and business firms it has come to have a distinctly business point of view. Members of the staff look upon themselves as business people and endeavor to meet problems of business men in a way that will secure confidence and approval. There can be no doubt that this close association with business has had a great influence upon the initiative, energy, and practical judgment of the men in the service. As an agency set up to assist business men it is essential that this organization should itself illustrate thoroughgoing business methods.

It is the purpose of the Bureau to furnish information at once scientific and practical. It is important to-day that business men should see conditions as a whole and should be able to value relative factors. If this broad outlook, however, were handled in an academic and theoretical way, it would not be what is wanted. Broad problems must be dealt with from the strictly practical point of view. It is necessary that the men who are making reports should themselves have had practical experience and have been in close touch with the firms that will later receive their information. With the tendency of business men to become more scientific, and with the parallel tendency of the Bureau to become more practical, there has been a close drawing together. There is to-day a closer harmony between our service and the business men of the country than ever before. In order that this spirit may be sustained and carried on in our service, we must continue to go forward. The time has come when this service should be something that will offer a life career to competent men. Otherwise it will be impossible to make continuous progress.

## CONDITIONS ESSENTIAL TO DEVELOPMENT.

The Bureau of Foreign and Domestic Commerce is at present in a position where it must compete with private firms for men. There is generally a great scarcity of men with foreign business training and experience. The Bureau is constantly losing some of its most effective men to private firms. Other men are remaining in its service with the hope that provisions will be made that will enable them to make it a career. It goes without saying that a great deal is lost when experienced men leave. Any business that has too large a "personnel turnover" has a great loss of efficiency. Too much of the Bureau's energy is now taken up with training new men. It is, therefore, essential to steady development that salaries be increased to a point where experienced men may be retained.

Another important development is cooperation. In general, the foreign representatives of the Bureau of Foreign and Domestic Commerce have cooperated very closely with American diplomatic and consular officers. Where close cooperation exists, there is no danger of overlapping. It is just as essential that there should be a proper esprit de corps in different branches of our service as that there should be the same spirit existing among the infantry, cavalry, and artillery in an Army. Anyone who endeavors to stir up petty jealousy or friction among the different services abroad is engaging in destructive, not constructive, work. There is to-day vastly more important work to be done abroad than can be adequately handled by representatives both of this Department and of the Department of State. In the field this is fully recognized. Foreign representatives of this Bureau and of the State Department have both shown that they were interested not so much in particular credit as in getting the work done. This same spirit has existed in Washington. A new condition has arisen wherein the volume of important foreign business has vastly increased, and adjustment is necessary to this situation. Nothing can be done for our foreign service, as a whole, that will be of such genuine benefit as the development of an earnest spirit of cooperation.

If the foreign commercial service of our Government is to be on as high a plane as it should be, it needs public encouragement and support. The kind of men who will find their way into our foreign service are usually prepared to work for less compensation than they would expect in private business, provided some recognition is given of their public service. It is very discouraging to these men to feel that there is lack of understanding of foreign problems at home or lack of appreciation of the work that they are doing. The foreign representatives of the Bureau of Foreign and Domestic Commerce tour the United States before going to their posts and on returning from their posts, in order to have the closest possible contact with business men. The encouragement and approval given by business men have done more than anything else to put heart and energy into this service. The business men of the country are coming to meet our men more than halfway. There is no reason why the foreign commercial service of the Government should not have the same confidence and standing that have been accorded to the military and naval services. It should also have the same permanency. The time has come when the foreign commercial service should not be incidental, but a real factor in the safety and well-being of this country. There is much still to be done to place the service on a basis that will be permanent and progressive. The time when this problem should be seriously considered is not in the future, but during this present year.

### CHANGES IN ASSISTANT DIRECTORS' OFFICES.

During the year several changes have taken place in the positions of the Assistant Directors of the Bureau. Chauncey D. Snow resigned as First Assistant Director in December, 1918, to undertake an important investigation as a trade commissioner in Europe, with headquarters in Switzerland. It was subsequently found advisable to appoint him as commercial attaché in Paris, and he has been filling this post since March. Grosvenor M. Jones, who had been Second Assistant Director since February, 1918, was designated to take up Mr. Snow's work as First Assistant Director in February, 1919. Dr. R. S. MacElwee assumed the position of Second Assistant Director during the same month and, upon Mr. Jones's resignation on August 1, 1919, was appointed First Assistant Director. To fill the vacancy in the position of Second Assistant Director caused by Dr. MacElwee's promotion, Trade Commissioner H. G. Brock, who had been acting commercial attaché in the London office since March, 1919, and an employee of the Bureau since 1915, was appointed.

### DIVISION-CHIEF CHANGES.

In February, 1919, Perry J. Stevenson, who had been an assistant to the First Assistant Director, was made chief of the commercial attaché division to take the place of Eliot G. Mears. Mr. Mears was appointed a trade commissioner to make an investigation in Greece. In June C. E. Herring was appointed a trade commissioner to go to Europe and was succeeded as chief of the division of foreign investigations by H. D. Butler. In October, 1918, O. P. Hopkins was promoted to chief of the editorial division to succeed J. E. Fitzgerald, who resigned to take a position with the Chamber of Commerce of the United States. In the spring of 1919, Julius Klein, chief of the Latin American division, was appointed as commercial attaché at Buenos Aires, and was succeeded by C. A. McQueen, who had been assistant chief of the division. In the Far Eastern division F. R. Eldridge, assistant chief, was promoted to the position of chief to succeed C. M. Bishop, who resigned. During the year William C. Huntington, commercial attaché in Russia, returned to the Washington office, and is now in charge of the Russian division of the Bureau.

## COMMERCIAL ATTACHÉS.

### PERIOD OF READJUSTMENT.

The past year has been a year of readjustment for the commercial attaché service. The report for 1918 showed clearly how extensively the commercial attachés were engaged in war work. This continued up till the signing of the armistice in November. Plans were then made for the immediate resumption of the normal activities of trade promotion and investigation.

The readjustment period, however, brought its own special problems. For example, in Argentina, Brazil, Japan, and Australia, our representatives have been busy with the difficulties involved in the sudden arrival of goods far in excess of immediate needs. Through their cooperation, the situation was handled effectively without loss to importers, exporters, or bankers. In England, France, Italy, Spain, Holland, and Denmark the attachés have had to deal with questions arising out of the relaxation and modification of war-time trade restrictions. The value of resident representatives abroad who were available for forwarding such information and who could instantly cable advice for American manufacturers and exporters has been especially noticeable in the handling of such questions. It was, of course, impossible and undesirable that the attachés should give up entirely their activities of a war nature. Our representatives have wound up as speedily as practicable their work for such organizations as the War Trade Board, the War Industries Board and the Shipping Board, and during the coming year will be working almost exclusively on trade matters.

### WORK OF TRADE COMMISSIONERS UNDER SUPERVISION OF ATTACHÉS.

An important development in connection with the commercial attaché service was the sending out of trade commissioners to conduct general investigations under the direction and supervision of the commercial attachés. Early in the fiscal year Trade Commissioner Herman G. Brock was sent to London to assist Mr. Kennedy in carrying on the strictly commercial activities that were necessarily being pushed aside by the war work. Mr. Brock furnished the Bureau with timely reports and was also able to assist Mr. Kennedy materially.

Shortly after the armistice the Department of Commerce recognized the necessity for a greatly increased force in Europe in order to keep in the closest possible touch with important developments and trade tendencies. As increased funds would not be available until July 1, 1919, the President was asked by the Secretary of Commerce to allot $200,000 out of the "national security and defense" fund in order that investigators might be sent to Europe to study trade conditions under the direction of the commercial attachés in the same manner as had been tried out in London. This request was approved by the President, and immediately the task of securing competent men was begun.

By the latter part of February trade commissioners and clerks had been examined by the Civil Service Commission, selected by the Bureau, and despatched to Europe after instruction in Washington. The trade commissioners on special and independent investigations were assigned to the division of foreign investigations, while the work of the 10 trade commissioners on general investigations directly under the attachés was in the hands of the division of commercial attachés.

Space will permit only a brief résumé of the activities of these commissioners.

Fred W. Powell, at London, studied the British reconstruction program and activities. Leonard B. Gary investigated primarily British shipping subjects, and his reports have been of special interest to the United States Shipping Board.

Wilbur J. Page, at Paris, reported on markets for American leather, and then studied the French import restrictions, the French tariff, and French commercial relations. John F. Butler made general investigations, the most important one dealing with French markets for American cotton and cotton textiles. H. T. van Deusen studied traffic questions, including both inland and ocean transportation.

At Rome H. C. MacLean has specialized on Italian industrial problems, while M. Joseph Chiesa studied the Italian import restrictions and rendered valuable service in aiding the attaché to secure the importation of many American commodities.

William M. Strachan, after investigating the production and exploitation of tropical products in Central America and Colombia, was assigned to Spain, where he has been studying general questions, especially markets for American products.

At Copenhagen T. O. Klath has been engaged in looking into the sales possibilities for various products, including coal and clothing.

At The Hague Arthur H. Redfield has collected extensive material on Dutch industries of interest to American exporters, and has made a thorough study of the cooperative movement in Dutch commerce and agriculture.

With the exception of a few of the trade commissioners who will remain abroad for further service, these investigators all returned shortly after the close of the fiscal year, and their reports are being made available to the business public.

The Bureau feels that these short but intensive investigations at this time have been a good investment to our manufacturers and exporters. The reports have been timely and of great value to the American business public during this readjustment period.

## NOTABLE RESULTS IN TRADE PROMOTION.

While at some posts the opportunity for trade promotion has been limited, there have been tangible and definite results that should be mentioned. The commercial attachés in South America have submitted special reports on the openings for American marine-insurance operations, markets for drawing instruments and architects' supplies, and German competition in all of its phases. The attachés at Copenhagen, The Hague, and Paris have studied, from first-hand sources, the status of the German dye industry. Our representatives at Paris and Rome were able to assist the important delegations or commissions representing the National Industrial Conference Board and the World Cotton Conference, while the London and Paris offices were of similar assistance to the commissions representing the shoe and leather trades and the Merchants and Manufacturers' Board of the Cleveland Chamber of Commerce.

The attaché service was informed by cable and mail of the exhibition of American knit goods and machinery held in Philadelphia in June under the auspices of the National Association of Hosiery and Knit Goods Manufacturers. Through publicity in foreign publications and personal interviews the attachés aroused considerable interest in this special line of American industry.

A striking example of the usefulness of the service is found in our cooperation with the United States Sugar Equalization Board. A representative of that board called upon the Bureau to ascertain whether the attachés could assist in opening up foreign markets for sugar. Cable inquiries were sent out quoting the regulated prices of the board, and the attachés were instructed to give the matter publicity, as well as to take it up directly with foreign importers. The results may be judged from the fact that soon the export demand became so heavy that the board found it necessary to restrict the exportation of sugar. The Sugar Equalization Board, in thanking the Bureau for its cooperation, wrote as follows: "Your Bureau, indeed, created a lively interest in the American sugar market throughout the world and we all appreciate what you did. Firm offers are coming in about as fast as the American refiners can fill the orders."

As another example of the utility of the service I may mention the cooperation of the Bureau with the bureau of markets of the State of South Dakota in finding markets for range horses in Europe, both for work purposes and as food in certain countries where horse meat is a standard article of diet.

## IMPROVEMENTS IN THE SERVICE.

As a result of the funds appropriated by Congress to meet the increased cost of living abroad, the Bureau was able to grant to the attachés and their secretaries post allowances that were urgently needed. Even with these increases in income three of the attachés resigned during the year to accept more remunerative positions in private employ. As for secretaries, it has been impossible at many posts to obtain or retain capable men, because of the low salary limit imposed by law and the exceptionally high cost of living abroad.

Cooperation with the representatives of the Department of State has been especially noteworthy during the past year. Our representative at Melbourne was temporarily in charge of the Melbourne consulate, while at another time the consul was in charge of our office pending the arrival of Mr. Ferrin. At several of the posts the attachés are preparing weekly reports for the ambassadors or ministers covering economic, financial, and commercial developments. Mr. Arnold, at Peking, was engaged during all of 1918 in the work of the State Department in connection with the revision of the Chinese tariff, a matter of prime commercial importance. Reports of mutually helpful relations at practically every post have been received from either the commercial attachés or representatives of the Department of State. In Washington arrangements have been made for supplying the foreign-trade adviser's office of the State Department with copies of all reports from the commercial attachés.

### NEEDS OF THE SERVICE.

New posts were established during the year at Rome and Madrid, rounding out the effectiveness of our European service. With the increased funds for the fiscal year 1920, offices have been or will be opened in Mexico City, Mexico, and Santiago, Chile, and the post at Berlin will undoubtedly be reopened. There are still countries that should be covered by the attaché service. Switzerland, Canada, Cuba, Central America, Colombia and Venezuela, Turkey, Austria, and the Balkans would be profitable fields.

It is gratifying to report that, with the increased funds at our disposal, it has been possible to give our attachés incomes more in keeping with the responsibilities and character of their work, although there is still room for improvement.

The greatest handicap at the present time is the limitation as to the number and salaries of clerks to commercial attachés. With the growth in the service and the expansion of the work it would seem advisable to remove the limitation of one clerk to each attaché. It is imperative that the salary limitation of $1,500 be removed at the earliest opportunity. Even during the past two years, with post allowances, it has not been possible to retain or secure the services of competent secretaries. At the present time there are only five secretaries, one of whom is a native Chinese, and seven vacancies exist. Although Congress granted larger appropriations for the fiscal year 1920 in order to increase the salaries of the commercial attachés, it did not remove the $1,500 limitation on the salaries of the secretaries, and, furthermore, it did not provide funds for the granting of post allowances. The result has thus been a serious reduction in the income of the latter employees, and this fact will make it increasingly difficult to retain the services of competent men. As the Bureau is now limited to sending out only unmarried men, and as the employment of local clerical help is not satisfactory or advisable where important and confidential matters are handled, it is hoped that relief will be granted by Congress at the earliest possible date. In this connection it should be stated that other Government organizations find it necessary to pay as high as $3,600, including salary and post allowance, for clerical work that is no more exacting or important.

### INCREASE IN WORK AT WASHINGTON OFFICE.

It was found possible during the year to increase slightly the staff of the division of commercial attachés, permitting a more scientific division of labor, with a resulting increase in efficiency. The volume of correspondence has increased with the establishment of new posts, as well as with the enlargement of the staffs of the offices abroad, especially in Europe, by reason of the large number of field employees. It is hoped that it will be possible to increase still further the directing staff in Washington, as it is not economical to spend increased sums in the field without making provision for handling reports and correspondence in such fashion that the business public may obtain the maximum benefit from this material. It is expected that trade commissioners will be assigned to the offices of commercial attachés in South America, the Orient, and Europe during the coming year, and this additional volume of work will make doubly necessary an adequate organization in the Washington headquarters of the division of commercial attachés.

### ACTIVITIES OF ATTACHÉS DURING THE YEAR.

#### LONDON.

Philip B. Kennedy, at London, has continued to be engaged in war work in addition to the normal activities of his office. Besides handling mineral and tin problems for the War Trade Board and assisting the War Department in the purchasing of urgently needed materials, Mr. Kennedy took over during the latter part of the year the entire handling of the Swedish iron ore and Norwegian molybdenum contracts, for which the President put at the disposal of the Secretary of Commerce $6,000,000 out of the "national security and defense" fund. Mr. Kennedy has cooperated closely with the Ambassador and the consul general in the matter of British import restrictions, which have been of special interest to American manufacturers interested in British markets.

One of the most important features of the work in London during the year was the cooperation between the office of the commercial attaché and the American Chamber of Commerce in London. The attaché was a consulting director of the chamber and an ex officio member of the trade information committee, and his office was represented at the weekly meetings of the committee.

The office in London had the opportunity to make first-hand investigations of markets for American products. For example, the possibilities for the sale of American cottonseed-hull fiber were carefully analyzed, and a detailed study was made of recent developments in the British paper-manufacturing industry and in the development of substitutes for textiles. Through the commercial attaché American producers of dyestuffs were put in touch with officials of the Italian Government interested in procuring American dyes and dyestuffs.

Mr. Kennedy represented the United States unofficially at the Interallied Parliamentary Conference and submitted extensive reports upon its deliberations.

During April Commercial Attaché Kennedy returned to the United States in order to confer with officials of the Bureau and meet business men interested in post-war conditions in England. The customary tour of commercial centers was made, and a large number of conferences were held.

As a result of an invitation extended through Mr. Kennedy to the Chamber of Commerce of the United States in behalf of the associated chambers of commerce in Great Britain, the Chamber of Commerce of the United States decided to bring to this country in the early fall, for a discussion of industrial and financial reconstruction problems, commercial delegations from the Allied Nations in Europe.

[Mr. Kennedy was appointed Director of the Bureau of Foreign and Domestic Commerce in July, 1919.]

### PARIS.

Pierce C. Williams, at Paris, in addition to his duties as commercial attaché, was engaged in various war activities. He organized and operated, under the direction of the War Trade Board representative, the American office of the Interallied Contingent Commission, and continued to assist in the regular work of the War Trade Board. As a result of an extensive tour through the devastated regions, Mr. Williams was able to submit timely and valuable reports on the subject of French industrial reconstruction. The attaché kept the Bureau and the business public fully informed of the important developments affecting American trade—such as import restrictions and the formation of consortiums and comptoirs—and suggested the adoption by American interests of the principle of cooperative selling in French markets. Shortly before returning to the United States in December, Mr. Williams made an investigation of economic conditions in Switzerland. His visits to our business centers were especially valuable in view of the widespread interest in France and French reconstruction problems. Shortly after Mr. Williams's resignation to enter private employ, Chauncey Depew Snow, who had been first assistant chief of the Bureau, was appointed as his successor, taking charge in Paris on March 24, 1919.

Mr. Snow has likewise kept in intimate touch with reconstruction problems. Even with the increased assistance placed at the disposal of the attaché, it has been difficult to give adequate attention to the increasing number of American commercial representatives and industrial commissions that have called upon our representatives for aid and counsel. Tariff questions and changes in import restrictions have been closely followed. The attaché has cooperated with the Rhineland High Commission, the officials in charge of the sale of Army supplies and equipment, and the Supreme Economic Council on important commercial problems, and has assisted in the increasing activities of the American Chamber of Commerce. As an example of the tangible results accomplished by Mr. Snow, the assistance given to individual import applications for American goods, even to the extent of preventing their confiscation, may be mentioned.

### COPENHAGEN.

At the beginning of the fiscal year Erwin W. Thompson was in London, continuing the work with the War Trade Board which he began in March in connection with trade agreements with the Netherlands and Denmark. The Bureau was then obliged to transfer him back to his station in Copenhagen, because of the pressing need for detailed trade information concerning Scandinavia and Germany. Mr. Thompson returned to Copenhagen in July and resumed his intensive study of the Scandinavian and German press. This study, and daily contact with commercial and financial men throughout the Baltic region, enabled him to furnish the Bureau with authoritative reports on economic subjects treated in detail and in their relation to world conditions. A considerable number of these reports were published in Commerce Reports, but an even larger portion were of a confidential nature.

Because of his intimate knowledge of Danish financing and trading companies, Mr. Thompson was able to work out plans for financing shipments of American cotton and other commodities into the new Baltic countries by a system of dividing up the credits between the American shipper and the Danish institutions in a way that keeps the American shipper always secured by safe shipping or warehouse documents. Experience in guiding the organization of a new cotton business in Holland during the war enabled Mr. Thompson to make specifications for new facilities in Copenhagen for handling this Baltic transshipment trade.

Danish importers found a warm welcome in the office of the attaché, where they felt free to discuss their requirements and difficulties. American exporters visiting Denmark were thus able to find in the office up-to-date information as to prospective purchasers and their requirements and the ways of meeting the numerous difficulties growing out of the blockade.

As a result of one of the attaché's reports, the United States Shipping Board was enabled to secure from a Danish factory large Diesel engines that were urgently needed.

Other special activities included an investigation of textile substitutes, a study of methods to be used in the adjustment of trade disputes, a survey of Scandinavian sources of supply of foodstuffs and other products for the American Expeditionary Forces, and efforts in relation to the establishment of an American chamber of commerce in Copenhagen.

### THE HAGUE.

During the entire year Paul L. Edwards has acted as the American representative on the Interallied Trade Committee at The Hague. Mr. Edwards served as the agent of the War Trade Board and the American Minister in carrying out the various agreements with the Dutch Government, including the handling of the correspondence with the Netherlands Oversea Trust. During November, 1918, a visit was made to London to confer with allied representatives regarding the various Dutch economic agreements. Several trips were made to Paris to confer with the Supreme Blockade Council with reference to general and financial blockade administration and the shipping of foodstuffs to Germany under the Brussels agreement.

Despite these activities of a war-time character, Mr. Edwards has been able to keep the Department and our trade interests informed of relaxations and modifications which permitted a resumption of prewar trade activities, in addition to reporting on current commercial and financial conditions in the Netherlands and Germany.

### PETROGRAD.

Commercial Attaché William C. Huntington spent most of the year in the United States on account of the unsettled conditions in Russia. During the early part of the fiscal year he was in Moscow aiding our diplomatic and consular officers. He left Russia in the fall, reaching the United States in November after visiting Stockholm, London, and Paris. In Washington, Mr. Huntington has held many conferences with officials of other Government departments interested in Russia, such as the War and Navy Departments and the Department of State. Besides making numerous addresses, the attaché has been engaged in organizing a Russian division in the Bureau, utilizing the material gathered during his stay in Russia.

### MADRID.

In the fall of 1918 it was decided to establish a commercial attaché post at Madrid, and the position was offered to William F. Montavon, who had served in Lima, Peru. After the resignation of Mr. Montavon, Chester Lloyd Jones, chief of the bureau of foreign investigations of the War Trade Board, was appointed on January 17, 1919. After a preliminary trip to important commercial centers, Mr. Jones sailed in February and opened his office on March 5, 1919. Through the cooperation of the American Ambassador, direct relations with Spanish governmental offices have been established.

At this post the work has been largely trade promotional in character—bringing together American firms interested in finding markets in Spain or aiding Spanish firms desirous of getting in touch with American sources of supply. As an aid in this work one room has been set aside as a catalogue and periodical room for interested buyers. Mr. Jones has assisted the embassy in connection with our commercial treaty relations with Spain and has also kept in close touch with proposed tariff legislation. He secured the revision of discriminating tariff classifications affecting American trade. Ambassador Joseph E. Willard has expressed his gratification at the valuable services rendered by Mr. Jones, and has recommended the appointment of additional assistants in the office of the commercial attaché. He states that the attaché was largely responsible for the recent granting to a New York company of an important concession for exploiting potash deposits north of Barcelona, and that, in the estimation of the embassy, this single achievement is sufficient to justify the maintenance of the commercial attaché's office and the expenditure that it involves.

Other activities worthy of special mention include assistance to the liquidation commission of the army, cooperation with the American Chamber of Commerce in Barcelona, and reports on Spanish trade conditions.

### ROME.

The second new post established during the year was at Rome. The Bureau has felt for some time the need for representation in Italy, in order to meet the growing demands of the business public. Alfred P. Dennis, who had been actively engaged in business, was appointed to this post on January 2, 1919. After a short trip to commercial centers, Mr. Dennis sailed in February and reached his post in March, 1919. Mr. Dennis has formed valuable contacts in both Italian governmental and commercial circles and during the three months since the opening of the office the attaché has been able to report several definite achievements. As a result of his efforts and those of his assistants, import permits were issued by the Italian authorities for 8,000 packages of American merchandise that had been held at the port of Genoa for six months. American tractors, shoes, hosiery, tubing, steel, and chemicals were included among the products admitted upon the representations of the attaché's office. Mr. Dennis assisted the embassy in securing equal treatment for American goods discriminated against in Italian treaties with other nations. Another important feature of the attaché's work has been his discussion, with the director of economic policy and the director of customs, of questions relating to the admission of American products into Italy. Mr. Dennis has also been engaged in aiding firms seeking to establish themselves in the Italian market, giving special attention to the opportunity for American coal.

### PEKING.

During the first half of the year Commercial Attaché Julean Arnold was stationed at Shanghai, serving as chairman of the International Maritime Customs Conference. This work was undertaken by the commercial attaché at the request of the Department of State. During Mr. Arnold's absence the office at Peking was in charge of Commercial Attaché A. W. Ferrin and Trade Commissioner Paul P. Whitham. Mr. Ferrin continued at Peking his studies of Chinese financial and investment problems. In cooperation with the representative of the War Trade Board, Charles Denby, Mr. Ferrin initiated negotiations for the sale of 5,000 cars and 100 locomotives to the Chinese Government railways under a car-trust agreement. During the period between Mr. Ferrin's departure from Peking in September and Mr. Arnold's arrival, Trade Commissioner Whitham was in charge of the commercial attaché's office. Mr. Whitham's activities were largely connected with the transportation problems of China along the line of his regular trade-commissioner investigation.

In few sections of the world has there been as great an opportunity for trade promotion as in China, and Mr. Arnold has been able to produce concrete and tangible results. He assisted in the organization of a new American bank in China, as well as in the organization of a joint Chinese-American bank. As a result of his efforts equipment for 10 cotton mills was purchased and installed in China. The attaché aided in establishing an American tannery, and had a share in the sale of American cars and railway equipment, besides aiding American architects in securing building contracts in China.

In addition to these definite results Mr. Arnold gave valuable aid to American commerce in several indirect ways. With the aid of a motion-picture outfit American industrial films have been exhibited in order to acquaint the Chinese business public with American equipment and American methods of production. The attaché has worked for the protection of American trade-marks, and has furthered the establishment of an American news service and better shipping facilities to China. With the aid of American consular officers a handbook on Chinese trade and commercial conditions has been prepared, which will be published in two volumes during the present fiscal year. Mr. Arnold has also been of service to American commercial representatives in China, as well as to the American Legation. It is expected that during the coming fiscal year Mr. Arnold will return to the United States in order to confer with officials of the Bureau and with American business men interested in Chinese trade.

### TOKYO.

Commercial Attaché Frank R. Rutter was engaged up to the signing of the armistice in war work connected with the problems arising out of the restrictions of trade and in studying industrial and economic conditions in Japan. Mr. Rutter left for the United States in December in order to accept an important position on the staff of the Bureau in Washington. Pending the appointment of his successor, James A. Rabbitt of the War Trade Board was in charge of the office. James F. Abbott, who has had an extended experience in connection with Japanese matters, was appointed on January 11, 1919, and proceeded to his post after visiting the leading commercial centers in the East, the Middle West, and on the Pacific coast. Since his arrival in March, Mr. Abbott has been engaged in renewing contacts in Japan and keeping the Bureau and the American business public acquainted with the progress of commercial developments during the period of readjustment. Special attention has been given to the problem of Japanese and American cooperation in industrial enterprises and other important problems connected with our trade with Japan. As a result of the representations of Mr. Abbott, the tariff classification of linoleum was changed to one more favorable to the American industry.

### MELBOURNE.

Pending the arrival of A. W. Ferrin from China, Howard A. Treat, secretary to the trade commissioner, was in charge of the Melbourne office. Mr. Treat left Australia for the United States in September, and until the latter part of November the office was in charge of the American consul, through the courtesy and cooperation of the Department of State. After his arrival on November 22, Mr. Ferrin established friendly relations with Australian Government officials and business men. Through addresses before commercial bodies and by means of press contributions, the commissioner has aided in removing misunderstandings regarding American trade methods and ideals. Another important service has been in connection with the amicable settlement of large claims made against American exporters by Australian importers. It has been possible for Mr. Ferrin to do excellent trade-promotion work, and, through his aiding Australians to obtain American agencies, substantial business has resulted.

In addition to furnishing the Australian business public with information concerning American sources of supply, Mr. Ferrin has submitted to the Bureau frequent reports on the industrial, financial, and commercial situation in Australia. Among the important openings for American products may be mentioned the inauguration of negotiations for the purchase of large quantities of American supplies by the Australian repatriation board for the erection of war-service homes. Mr. Ferrin found, during the course of his investigations, that American exporters had various interpretations for certain terms in foreign trade technique, and a campaign of education has been started in order to unify American trade practice.

During the serious illness of the American consul at Melbourne, the Department of Commerce was glad to be of service to the Department of State by having Mr. Ferrin take charge temporarily of the American consulate.

### BUENOS AIRES.

The office of the commercial attaché at Buenos Aires was largely occupied with war work during the year. Commercial Attaché Robert S. Barrett was also the representative of the War Trade Board and the Shipping Board. In the first capacity he had charge of enemy trade matters. Mr. Barrett secured the cooperation of the commercial representatives of the allied Governments and organized a committee, of which he was elected chairman, to take joint action upon all enemy trade matters. He also suggested and assisted in the organization of the Allied Chamber of Commerce of Buenos Aires, consisting of representatives of the chambers of commerce of all the allied nations in Argentina. This organization was effective in suppressing enemy trade during the war.

As representative of the Shipping Board, Mr. Barrett was charged with the allocation of cargo on Shipping Board boats from the River Plate to United States ports. Mr. Barrett made exhaustive reports to the Shipping Board on conditions in Argentina, so that they could provide vessels to move cargo from the River Plate which was urgently needed for war purposes. During the shipping strike in Buenos Aires from January to March, 1918, he was actively engaged in conferences with shipowners, agents, Government officials, and business men, and helped to bring about a successful termination of the strike which virtually paralyzed the port of Buenos Aires for 73 days.

The commercial attaché devoted considerable time to trade promotion. Largely through his efforts, the United States Chamber of

Commerce in Buenos Aires was organized and is now in a flourishing condition. Many representatives of American firms were assisted, and in one instance an initial order of $100,000 worth of rubber goods was secured. During the troublesome period following the armistice, Mr. Barrett was of assistance in arranging for the acceptance of canceled orders.

Mr. Barrett kept the Bureau fully informed of conditions in Argentina and made frequent and extensive reports on the production of cereals, packing-house products, and quebracho wood, and on banking, insurance, shipping, Government and provincial loans, and other timely subjects.

Mr. Barrett expressed the desire to resign on April 1 to enter private business, but returned to the United States and spent three months in conferring with manufacturers and business men before leaving the Bureau's service.

Julius Klein, who had served as chief of the Latin American division of the Bureau, was appointed as Mr. Barrett's successor on May 1, 1919, leaving shortly thereafter for Buenos Aires. He had not reached his post by the end of the fiscal year, since he was so unfortunate as to be shipwrecked off the coast of Peru.

### RIO DE JANEIRO.

In August, 1918, J. E. Philippi was appointed commercial attaché at Rio de Janeiro. Mr. Philippi brought to the service a number of years of responsible business experience in Brazil as the representative of a large American firm. After the usual tour to interested commercial centers Mr. Philippi sailed for his post, arriving on November 3, 1918.

He has devoted considerable time to a unification of the American commercial organizations in Brazil into an effective body, the American Chamber of Commerce for Brazil. This organization, with the aid of Mr. Philippi, has assisted in the negotiations between the chamber of commerce of the United States and the Brazilian chamber of commerce with regard to an agreement for the arbitration of commercial disputes. The attaché has been making a close study of the Brazilian tariff as it affects American trade relations.

Mr. Philippi rendered valuable service during the readjustment period following the armistice. Unusually heavy import shipments were received, and in many lines stocks were largely in excess of immediate needs. By careful cooperation with the banks in Rio de Janeiro, the Brazilian importers, and the American exporters, Mr. Philippi was instrumental in working out effective plans for taking care of the situation without loss to the parties interested.

The attaché has kept the Bureau informed of the need for increased shipping facilities for our Brazilian trade, as well as concerning competitive freight rates and service. In addition to these special activities, there have been the regular features of an attaché's work, such as reports, investigations of markets for American products, and assistance to American exporters.

### LIMA.

During the greater part of the year the office at Lima has been in charge of Robert E. Hurd, the secretary. Commercial Attaché William F. Montavon returned to Washington in October in order to confer with exporters interested in Peru and to have a vacation before proceeding to the post at Madrid. However, Mr. Montavon decided later to accept an important post with a private organization at an increased salary. His trip through the United States was highly successful.

While at Lima the attaché was chairman of the subcommittee of the Allied Conference of Ministers which met regularly to consider war trade problems. After the attaché's departure, Mr. Hurd continued these activities, acting as secretary for the organization. Mr. Hurd has kept the Bureau informed of trade developments in Peru, has submitted reports and trade opportunities, and has investigated trade disputes.

## TRADE COMMISSIONERS.

Trade commissioners are of two types, those that conduct surveys of the general commercial and economic conditions in a given field and those that investigate markets for a particular product or group of products in one or more foreign countries. The first group of trade commissioners is somewhat similar to the commercial attachés, although there are the following points of distinction:

(1) Commercial attachés are attached to the staff of the United States ambassador or minister in a foreign country, while the trade commissioners, whether assigned to one or more countries for a general investigation or making a special investigation, have no official connection with the Department of State.

(2) The commercial attaché is largely confined to the capital of a country, while trade commissioners are expected to investigate conditions in all the trade centers and have no fixed post.

(3) The trade commissioners will continue to be assigned with the primary purpose of obtaining up-to-date information regarding the economic condition and trade relations of countries concerning which this Bureau has comparatively little original information. The chief function of the trade commissioner, whether assigned to a general investigation or to a commodity study, is that of an investigator, while the commercial attaché is primarily the commercial adviser to the minister or ambassador and is a commercial diplomat devoting himself largely to the cultivation of better commercial relations between the United States and foreign countries.

The primary function of the trade commissioners is the thorough investigation of conditions that American manufacturers must meet in foreign markets rather than the direct promotion of the sale of American goods. The results of the Bureau's investigations have met with wide appreciation on the part of American producers and exporters, as the information gathered by our men in the field is not readily obtainable from other sources.

Trade commissioners are appointed after a written and oral examination by the Bureau. After appointment they familiarize themselves with the work of the Bureau and the data already available that will assist them in their investigation, after which the scope of their foreign work is tentatively outlined. Special care is taken to provide trade commissioners with all available statistical information which would otherwise have to be obtained during the course of the investigation abroad, with consequent loss of valuable time in the field. In addition to acquainting themselves with the pertinent information available in the Bureau, the trade commissioners during their stay in Washington familiarize themselves with any work pertaining to their investigations that is being done by other Government offices.

Upon the completion of their preliminary work in the Bureau, the trade commissioners make brief trips to important commercial and manufacturing centers (the list of these varying according to the nature of the investigation) for the purpose of getting first-hand suggestions from American manufacturers and exporters. Circulars are also prepared notifying the business public of these proposed investigations, and business men who do not have the opportunity of meeting the commissioners when they visit the different centers are asked to communicate with them, giving their suggestions and submitting any special problems in which they are interested.

After their return to the United States, trade commissioners revisit the important trade centers, making more extended trips and personally informing those interested in the markets they have studied concerning the results of their survey.

The complete record of a trade commissioner's foreign investigation is by no means contained in his published reports, as there is first-hand information of great value and importance that can be given more quickly and in more complete detail by word of mouth. Such interviews also tend to create a keen interest in the forthcoming reports of the trade commissioner. Chambers of commerce and other trade organizations have cooperated with the Bureau in this work, by giving suggestions as to new work to be undertaken, obtaining selected audiences for trade commissioners when they visit important trade centers, and helping the Bureau to bring the results of these investigations to the attention of the business men directly interested.

### WORK OF TRADE COMMISSIONERS IN CONNECTION WITH WAR ACTIVITIES.

During the past year the work of practically all the trade commissioners has proved of distinct value in connection with the Government's war activities, and the division of foreign investigations has cooperated to the fullest extent with officials of the War Trade Board, the War Industries Board, the Council of National Defense, the Shipping Board, the War Department, the Department of State, and other Government organizations, by giving them first-hand information as soon as it was received from our agents in the field and by keeping various branches of these war bodies informed of propaganda abroad and general current conditions in the belligerent and neutral countries.

As an instance of this Bureau's cooperation, it may be mentioned that Trade Commissioner Axel H. Oxholm was loaned to the purchasing agent (for Great Britain) of the American Expeditionary Force to assist in purchases of Scandinavian timber which were made through London prior to the signing of the armistice. Because of shipping conditions, however, Mr. Oxholm was sent to France by the purchasing agent to inspect various cargoes of timber which had been received there, and he rendered a report on the condition of the timber and aided in advising the purchasing agent concerning problems of storing and piling. He then returned to England and worked with an arbitration board in London in the interest of the American Expeditionary Force. It is gratifying to know from a letter received from the acting purchasing agent that, through Mr. Oxholm's efforts, the work of liquidating the claims in connection with the timber shipments was greatly expedited and that his work was of great value.

Important assistance in connection with war work was given by Norman L. Anderson, through reporting current matters of interest in the Scandinavian countries, Finland, and Germany.

Nels A. Bengtson, trade commissioner at Christiania, was assigned, at the request of the War Trade Board, to work with its special representative stationed in Norway. Thus, Mr. Bengtson was able to obtain vital information regarding blockade conditions and was in a position to comprehend all essential aspects of the business situation.

### TRADE-PROMOTIVE WORK ASIDE FROM PUBLISHED REPORTS.

As has been previously stated, the published reports do not represent the sum total of the trade commissioners' efforts to extend foreign markets for American goods. Practically all of the trade commissioners, at different times, have been of very great assistance in clearing up misunderstandings and disputes between American manufacturers and exporters and their foreign customers. Specific explanations regarding the reasons for increased freight rates, delays in transportation as a result of the war, the necessity for the use of inferior materials, etc., have been of extreme value in dispelling misapprehensions and bringing about closer commercial relations. Such services are especially beneficial when there is a tendency on the part of the foreign importers to use European goods or where a prejudice exists against American products, though these are frequently better in quality and cheaper in price. Contact maintained by the commissioners with American salesmen abroad has also been of marked value to American foreign trade. Through attending demonstrations of American goods and reporting the results, the investigators have been enabled to convey to American manufacturers information of an especially vital character.

Another feature of the work done by our trade commissioners abroad is the submitting of "Foreign Trade Opportunities" setting forth the needs of foreign importers. In this way many valuable orders have been placed, and the Bureau is constantly receiving letters from firms in this country expressing their appreciation of our "Foreign Trade Opportunity" service, which is a regular feature of Commerce Reports, our daily trade paper.

The samples and catalogues collected by our trade commissioners while on their investigations have also been of great benefit in clearly showing to the American manufacturer the tastes of his foreign customers and the kind of articles turned out by his competitors.

The trade commissioners, on numerous occasions, have been instrumental in bringing about important transactions between American manufacturers and foreign firms.

## SUMMARIZED STATEMENT OF TRADE INVESTIGATIONS.

The following table indicates all the investigations that had not been completed at the beginning of the fiscal year 1919. Those marked with an asterisk are now completed, although in a few instances final reports have not yet been finished.

### SPECIFIC INVESTIGATIONS.

| Subject of investigation. | Trade commissioner. | Country. |
|---|---|---|
| *Lumber | Brown, N. C. | Southern Europe. |
| Mineral resources | Clements, J. M. | Far East. |
| Mining industries | De Kalb, C. | Spain. |
| *Furniture | Everley, H. E. | South America. |
| *Construction materials and machinery | Ewing, W. W. | Do. |
| Textiles | Garry, L. S. | Do. |
| Banking and finance | Grady, H. F. | United Kingdom. |
| *Agricultural implements | Groves, H. L. | France and Algeria. |
| *Motor vehicles | Hanch, C. C. | Europe. |
| Leather | Hertz, N. L. | Do. |
| Machine-tool industry | Luchars, A. | Do. |
| *Industrial machinery | Marshall, W. C. | Italy. |
| Phosphate rock | Memminger, C. C. | Europe. |
| *Lumber | Oxholm, A. H. | Scandinavian countries. |
| Industrial machinery | Rastall, W. H. | Far East. |
| Railway equipment | Rhea, F. R. | Do. |
| *Jewelry and silverware | Rosenthal, S. A. | South America. |
| *Advertising methods | Sanger, J. W. | Do. |
| *Lumber | Simmons, R. E. | Russia, European and Asiatic. |
| *Electrical goods | Smart, Oliver M. | Italy. |
| Do | Smith, P. S. | Spain. |
| *Tropical products | Strachan, W. M. | Central America and Colombia. |
| *Lumber | Walker, J. R. | United Kingdom, Belgium, Netherlands, and France. |
| Ports and transportation facilities | Whitham, P. P. | Far East. |
| *Chemical industries | Wigglesworth, H. | France, United Kingdom, and Belgium. |
| *Industrial machinery | Wood, C. P. | France. |
| *Banking | Young, A. N. | Spain. |

### INVESTIGATIONS OF GENERAL COMMERCIAL AND ECONOMIC CONDITIONS.

| Trade commissioner. | Country. | Trade commissioner. | Country. |
|---|---|---|---|
| Anderson, N. L. | Sweden. | Geringer, V. A. | Czechoslovakia. |
| Bell, P. L. | Colombia and Venezuela. | Lundquist, R. A. | Union of South Africa. |
| *Bengtson, N. A. | Norway. | *Mears, E. G. | Greece. |
| *Collings, H. T. | Belgium. | Schurz, W. L. | Bolivia and Paraguay. |
| *Feely, E. F. | Mexico. | *Van Norman, L. E. | Roumania. |
| Fowler, J. A. | Dutch East Indies. | *Wells, L. C. | France, Belgium, and Netherlands. |

## INVESTIGATIONS COMPLETED DURING THE YEAR.

### LUMBER INVESTIGATIONS.

The four lumber investigations conducted by Trade Commissioners Axel H. Oxholm, Roger E. Simmons, Nelson C. Brown, and John R. Walker were practically completed at the end of the fiscal year 1919, and their reports will appear in the near future. The territory covered by the commissioners included, respectively, Finland, Sweden, and Norway; Russia and Siberia; the Spanish Peninsula, Italy, and Greece; and Great Britain, France, Belgium, and the Netherlands.

Upon returning to this country, each commissioner made a tour of the principal lumber centers, giving first-hand information regarding the markets for lumber and the lumbering industry in the various countries visited.

It is gratifying to note that important suggestions made by our trade commissioners, such as the consideration of improved plans for reducing the loss in stumpage, etc., in this country, have been seriously considered by the lumber trade in general and will, no doubt, result in more attention being paid to conservation of our rapidly diminishing timber resources.

### FURNITURE.

The investigation conducted by Harold E. Everley into the South American markets for American furniture was completed at the end of the fiscal year. Mr. Everley's investigation has proved of great interest and value, and it is believed that his monographs will be of genuine assistance to American manufacturers and exporters of furniture. During the year the following monograph by Mr. Everley was published: Special Agents Series No. 176, "Furniture Markets of Chile, Peru, Bolivia, and Ecuador."

### CONSTRUCTION MATERIALS.

William W. Ewing has recently completed his investigation of the markets for construction materials and machinery in South America. He has made a very successful tour of the principal centers of this country, discussing his specialty with the leading manufacturers, who have given evidence of their interest in and appreciation of Mr. Ewing's work. He has finished his reports, and his final books will soon be available for distribution. There appeared during the year Mr. Ewing's monograph entitled "Construction Materials and Machinery in Chile, Peru, and Ecuador," Special Agents Series No. 175.

### AUTOMOBILES.

In the spring of the year Charles C. Hanch conducted a very short investigation of the automobile situation in Europe. Mr. Hanch is a keen observer, which fact, coupled with his broad knowledge of the American automobile industry, gives special significance to his survey of the European manufacturing and marketing conditions.

### INDUSTRIAL MACHINERY.

W. C. Marshall, as is the case with most of our commissioners returning from Europe, counsels that our producers and exporters exercise the greatest patience and tact, the better to cooperate with the Italian people, who need our aid so much at this time.

Charles P. Wood has practically completed his investigation of the needs for industrial machinery in France and Belgium and is returning to this country to give to the American business public important information collected during his stay abroad.

### JEWELRY AND SILVERWARE.

Samuel W. Rosenthal finished his investigation of the jewelry and silverware markets in Latin America and has returned to the

United States. He has been in close touch with the jewelry trade, and letters of appreciation coming from many corporations tell us of the reliable work done by Mr. Rosenthal and of the very complete and interesting data and samples that he has collected.

### ELECTRICAL GOODS.

Philip S. Smith, one of our experienced investigators in the Latin countries, has recently completed his investigation of markets for electrical goods in Spain. His data will be available in the late summer in the form of published reports. As Spain is of particular interest to American manufacturers at this time, there is a marked demand for conferences with Mr. Smith, as well as for his reports.

Through the commercial attaché and with the assistance of the trade commissioner, a representative of an aluminum company in Pennsylvania was brought into contact with the Sociedad Hidroeléctrica Española, of Madrid, from which he secured a contract for cable for a transmission line, amounting to approximately $750,000. From the same company the Bureau's representatives were able to turn to an American firm, in face of English and other European competition, an order for copper transmission wire worth $500,000.

During the year the following monograph by Mr. Smith was published: Special Agents Series No. 167, "Electrical Goods in Bolivia and Chile."

An investigation of the market for electrical goods in Italy was recently completed by Trade Commissioner Oliver M. Smart, who has now returned to this country and who will, within a short time, submit a report that will be published and brought to the attention of the trade. While Mr. Smart was in Italy only four months, the material that he gathered will enable the Bureau to provide a comprehensive view of the situation.

### ADVERTISING METHODS.

J. W. Sanger completed his investigation of advertising methods in South America during the last part of the fiscal year and has since given the advertising trade a résumé of his entire investigation. The unanimous and hearty approval of Mr. Sanger's work by the Association of National Advertisers, the American Association of Advertising Agencies, and the Associated Advertising Clubs of the World is very gratifying to the Bureau, as it proves indisputably that this experiment of an advertising and merchandising investigation in South America was a wise departure from beaten paths. In fact, it is the unquestionable value of such a study that has caused the Bureau to include Mr. Sanger's investigation in the Far East in its 1919 and 1920 plans, as described elsewhere in this report. During the year the Bureau published Mr. Sanger's monograph entitled "Advertising Methods in Cuba," Special Agents Series No. 178.

### PRODUCTION AND EXPORTATION OF TROPICAL PRODUCTS.

William M. Strachan, who was sent to investigate the production and exportation of certain tropical products in Central America and Colombia at the request of the United States Shipping Board, returned to the Bureau in December and submitted valuable information regarding general commercial conditions in Central American countries.

### CHEMICAL INDUSTRIES.

On a short trip to Europe, Trade Commissioner Henry Wigglesworth was enabled to get an accurate picture for the American chemical industries of the situation in European countries, enabling him to forecast after-the-war developments.

### AGRICULTURAL MACHINERY.

The investigation of the needs for agricultural machinery in France that was conducted by H. Lawrence Groves has been completed, and within a short time a monograph will go to press that promises to be of exceptional interest.

### FINANCIAL CONDITIONS.

An investigation of financial conditions in Spain has been conducted by Arthur N. Young and is now completed. Mr. Young is to return to this country and prepare a monograph regarding the financial situation and banking systems in the Peninsula.

### GENERAL COMMERCIAL AND ECONOMIC INVESTIGATIONS.

Norman L. Anderson, who was conducting a general investigation of commercial and economic conditions in Sweden, has been appointed commercial attaché to be stationed at Copenhagen, Denmark. Mr. Anderson's work in the past has been very commendable, and his reports have been numerous and interesting. We are sure that in his new assignment he will be of even greater service in the establishment of closer commercial relations and the furthering of American trade in Scandinavia.

Edward F. Feely, who was appointed trade commissioner to conduct a general investigation in Mexico, has been making a complete survey of the situation and has submitted, from time to time, very informative reports regarding the complicated Mexican situation. Mr. Feely has now been appointed commercial attaché at Mexico City, and his services as a trade commissioner have been discontinued.

Louis E. Van Norman was appointed trade commissioner to investigate general commercial and economic conditions in Roumania and was stationed at Bucharest for about six months. Because of a lack of contact with Roumania, the business men of this country have been eager to obtain and peruse Mr. Van Norman's reports. He arrived in this country in August and has been in consultation with persons interested in that country, which is generally considered the richest of the Balkan States. In cooperation with the legation at Bucharest and a number of prominent Roumanian merchants and leaders in shipping affairs, the trade commissioner was enabled to help lay the foundations for an American chamber of commerce in Roumania, modeled somewhat after the American Chamber of Commerce for the Levant. Such an organization will not only be of service in acquainting American business men with credit, investment, and other economic conditions in Roumania, but will serve also as a medium for introducing American methods and goods to the Roumanian people.

Leslie C. Wells was assigned to the party of the French Institute in the United States which has been in Europe making a tour of France, including the devastated regions. It is felt that Mr. Wells will be able to render material assistance to this mission in its purpose of strengthening the commerce of France in the United States.

Harry T. Collings has practically finished his work in Belgium and is returning to the United States to prepare a handbook on that country. Because of the importance of this post, however, it has been decided to appoint another commissioner to continue the work begun by Mr. Collings (this new assignment is incorporated under "Plans for new investigations").

Eliot G. Mears has completed his survey of the general commercial conditions existing in Greece and will embody in a report his data and conclusions. He has been ordered to proceed to Constantinople, where he will make a general report of commercial conditions in that interesting center. The work in this part of the world is important at the present time, and Mr. Mears may be depended on to furnish us with timely and reliable information.

Nels A. Bengtson has practically finished his investigation of the general commercial and economic situation in Norway and is returning to this country in September, when he will complete a short report on trade conditions in the Scandinavian countries. As Mr. Bengtson's periodic reports have covered first one field and then another in Norway, his post-war reports will give an excellent summary of all his studies.

## INVESTIGATIONS NOW IN PROGRESS.

### MINERAL RESOURCES.

J. Morgan Clements continues his investigation of mineral resources in China, but is progressing with some difficulty by reason of the slow travel and the inaccuracy of Chinese reports and maps regarding mineral deposits and mines. Constantly increasing interest has been shown in Mr. Clements's work; his periodic reports show that he is covering this field thoroughly and is obtaining data of much value.

The investigation of mines and mineral resources in Spain conducted by Courtenay De Kalb is to be continued for a while longer, because of the increased interest shown in the United States and the importance and quality of Mr. De Kalb's work. He has already submitted important reports on the various investment opportunities in this rapidly developing country.

### TEXTILES.

L. S. Garry, during the latter part of the fiscal year, was appointed trade commissioner to study the markets for textiles in South America and to continue the investigation conducted by W. A. Tucker, which was never completed, on account of Mr. Tucker's resignation after he had finished his work in Chile. Mr. Garry has prepared and submitted in a remarkably short time an excellent report on the markets for textiles in Argentina, and it is gratifying to know that he has been able to utilize a large part of the samples purchased by Mr. Tucker, after having their present value determined by local merchants. Mr. Garry's investigation is creating more than usual interest because of the keen competition in South America, and the textile trade will be able to use his reports to excellent advantage.

### FINANCIAL CONDITIONS.

H. F. Grady, who is continuing an investigation of the financial situation in England, has been ordered to continue his studies for a while longer, after which he will proceed to the Continent to conduct similar investigations. Mr. Grady's reports have been up to date and valuable, and the banking interests in this country have been distinctly pleased with the character of the work submitted.

### LEATHER.

A leather investigation in Europe conducted by Norman L. Hertz, who was especially designated for this work by the Tanners' Council, will be continued during the coming fiscal year, as this unquestionably is the time to obtain all possible information regarding the future markets for this product.

As a result of the shoe and leather trade investigation concluded in the past fiscal year bv Trade Commissioners C. E. Bosworth and H. G. Brock, the following reports have been published and distributed: Special Agents Series No. 173, "Shoe and Leather Trade of China and Japan," by Mr. Bosworth; No. 174, "Markets for Boots and Shoes in Chile and Bolivia," by Mr. Brock; No. 177, "Boots and Shoes, Leather, and Supplies in Argentina, Uruguay, and Paraguay," by Mr. Brock; No. 179, "Boots and Shoes, Leather, and Supplies in Brazil," by Mr. Brock.

### MACHINE-TOOL INDUSTRY.

Alexander Luchars has recently sailed from this country and is to make an investigation of the machine-tool industry in England and on the Continent. Mr. Luchars's familiarity with the machinery trade in Europe will enable him to make a quick yet comprehensive survey of the situation.

### INDUSTRIAL MACHINERY.

An investigation of industrial machinery in the Far East is being conducted by W. H. Rastall, who left this country in December. This investigation is proving of substantial interest, and Mr. Rastall, an engineer of excellent standing, is diligently gathering needed information. Mr. Rastall has made an economic survey of conditions in Japan and the Philippine Islands. He will arrive in India in August. After the completion of his work in that country, he will conclude with a study of the conditions in the Straits Settlements, the Dutch East Indies, and China.

### PORTS AND TRANSPORTATION FACILITIES.

Paul P. Whitham is conducting an investigation of transportation and port facilities in the Far East. He has made a remarkably complete investigation, having traveled some 35,000 miles and interviewed many prominent Chinese and Europeans who are informed on some phase of this vast problem. His reports have created great interest among people who are following developments in China. Mr. Whitham will complete his Chinese study this fall and, after making an economic survey of transportation and port conditions in Japan and the Philippines, will arrive in this country in the spring of 1920.

### GENERAL COMMERCIAL AND ECONOMIC INVESTIGATIONS.

P. L. Bell is continuing his general investigation in Colombia and Venezuela. He has now practically finished his survey of Colombia and has brought to light some extremely interesting conditions. His very thorough and comprehensive reports include such subjects as packing, cattle raising in the Bolivar region, pilferage, hardware and machinery, road-building machinery and railway supplies, credit methods, etc.

John A. Fowler is conducting in the Dutch East Indies and Straits Settlements an investigation of general commercial and economic conditions, and we are looking forward to his reports, which, we feel sure, will be read with keen interest by the American public.

Vladimir A. Geringer, who was recently appointed trade commissioner to make a general survey of the conditions in Czechoslovakia, is to continue his work in that country with headquarters at Prague. He is in a position to obtain very valuable information regarding the future markets for American goods in this new Republic and the surrounding countries.

R. A. Lundquist will complete his work in South Africa by the end of this year. Excellent general reports have been received from him, and he has done special, timely work in connection with commercial complaints arising from war conditions, delays in transportation, etc. He will also prepare a report on the electrical goods trade in South Africa. He will then proceed to India, according to plans, for a six months' study of electrical goods in that country, where but little has been done toward the promotion of sales of American electrical merchandise.

William L. Schurz was appointed trade commissioner in February to make a general investigation in Bolivia and Paraguay. His work, as planned, is a general commercial and economic investigation of these two countries, where none of our commissioners have been located before, though short visits to the principal centers have been made by several of our commodity investigators.

### PLANS FOR THE FISCAL YEAR 1920.

During the fiscal year 1920 the Bureau will conduct investigations in the various countries where it has been clearly shown that it is necessary to have a trade commissioner in the field, so that the Bureau can more effectively aid American business men to solve the difficult problems brought about by the changed conditions resulting from the war. Naturally, it is essential that thorough investigations should be carried on in allied and neutral Europe.

On account of the growing importance of Spanish markets, special attention is being given to a study of that country. A trade commissioner is already on the ground making a general survey, and Courtenay De Kalb will continue for several months his investigation of mineral resources.

It is also desirable that studies be made in Switzerland and in the two newly formed Republics of Czechoslovakia and Poland. The opening up of commercial relations with Germany and Austria necessitates the placing of two men specially trained to aid in the resumption of commercial relations with the central powers.

It is expected that trade commissioners making general economic investigations in Denmark and Poland will be in a position to make periodic trips into the Baltic Republics (Lithuania, Esthonia, Latvia, and Courland) to report on conditions there. It is apparent that studies of the countries on the border of Russia are of particular interest in connection with future diplomatic and commercial relations with that country, and it is hoped that these men, together with Vladimir A. Geringer at Prague, will be in a position to give us first-hand information of value.

Trade Commissioner Eliot G. Mears, who is proceeding to Constantinople, will report on conditions in the northern part of the Levant, and our representative in Egypt will take advantage of the newly completed railway connections to investigate conditions in Egypt, Mesopotamia, Syria, and the Sudan.

As before stated, R. A. Lundquist is finishing his work in South Africa and will proceed to British India about December to make a six months' survey of the markets for electrical goods in that country. Also, the Bureau will send a man specially versed in British Indian affairs to make a general study of trade conditions and opportunities for development.

The acute condition of the leather market makes it seem very advisable that a detailed investigation be conducted of the leather and raw-stock markets and resources of South America.

J. W. Sanger will continue his survey of advertising and merchandising methods, in which he was so successful in Latin America, and will shortly sail for the Far East for an extended study of this important subject in China, Japan, and the Dutch East Indies. On account of the importance of the rapidly developing commercial interests of China, another trade commissioner will shortly be appointed to study various commercial and economic phases of the Chinese situation, to supplement the work of Trade Commissioner Lynn W. Meekins, now en route to Peking.

Because of the ever-increasing importance of, and interest in, Latin America, it is proposed to assign one man to Argentina and one to Brazil. Also; an investigation of the markets for factory equipment and supplies in Argentina, Brazil, and Chile will be carried on. A trade commissioner will be assigned to the West Indies and another to Peru to conduct general investigations.

As the investment opportunities in South America are numerous and as there is a growing interest in this field, the Bureau also contemplates sending two men to make an investigation of investment opportunities and banking conditions in general.

## LATIN AMERICAN DIVISION.

Early in the war the accumulation of economic data on Latin America became known to the various war organizations in Washington, and, as a result, the division found itself called upon to cooperate very actively in many aspects of war work involving Latin American affairs. Although the quantity of material assembled was not extensive as compared with other similar collections, nevertheless the fact that it was all of very recent origin (for the most part since 1914), together with the fact that the data on any given subject could be produced within a few minutes, made the files of the division very useful and convenient. They were thrown open to properly accredited representatives of many Government offices engaged in war work. In fact, about 50 per cent of the time of the division during the duration of the war was given to the preparation of economic material for war uses and to assistance rendered to investigators from other Government offices. In some instances these organizations found it necessary to maintain members of their staffs on full-time work in the division.

The four offices of the War Department maintaining closest contact with the division were the military intelligence branch, the aircraft procurement division, the gas-defense service, and the Surgeon General's office. Of special importance was the material here available on castor beans and mahogany stocks available from Latin America; the supply of coconuts and cohune nuts, for the information of the gas-defense service in the search for charcoal; and the procurement of cinchona bark and quinine in Latin America. A great variety of general information was sought by the military intelligence branch in connection with the activities of its agents.

The division was in particularly close touch with the Shipping Board because of the necessity for very careful study of ship service to Latin America with a view to curtailing that service to a minimum in order to supply tonnage for transatlantic troop and munition movements. An extensive investigation was conducted during many months of the war period with a view to recommending the elimination of less essential imports, involving study of the effect of such curtailments upon conditions, political as well as economic, in given countries. In this connection much time was given to the study of such important trade movements as those in coffee, manganese, linseed, nitrate, bananas, vegetable wax and oils, and quebracho. In each case efforts were made to stimulate importation in more compact form or from nearer regions. As the Shipping Board established its own fund of information, the files of this division were called upon for a foundation of data in respect to such questions as Mexican petroleum, Latin American merchant marine, fuel supplies of South American countries, interned German shipping in Latin American ports, and Japanese ship movements to South America.

The division was called upon constantly for advice on the granting of licenses for exports to Latin America, with special reference to the actual necessity for the given commodity in the consuming countries. The War Trade Board found it necessary to maintain an investigator in the division whose entire time was occupied with such problems as were transmitted to the division by that board.

These problems involved studies of the foodstuff supplies, railway facilities, industrial development, and many other minor topics. As the War Trade Board undertook to establish its own field service, its various appointees were given special preliminary training in the division before departing for their posts in Latin America. This work necessitated considerable attention on the part of the division in order that each representative might be equipped for his task in the shortest possible interval.

The division was called upon to supply for the Food Administration a number of comprehensive tabulations with regard to the trade in sisal fiber, sugar, bananas, coffee, and cereals. Frequent contact was necessitated also by the complaints of business firms in relation to the activities of the Food Administration with regard to the products in which they were interested.

The Geological Survey was engaged in many war investigations, and in the course of its studies considerable material was requested of and supplied by the Latin American division. The topics covered included reports on the Latin American supplies and the proprietary control of such minerals as nitrate, petroleum, coal, tin, zinc, manganese, platinum, antimony, and tungsten. Investigators employed in the compilation of the pamphlets on economic control of various minerals, issued by the Department of the Interior, spent a great deal of time in consulting the files of the division and making notes for use in their work.

The Federal Reserve Board requested this division to report on the exchange situation in the more important Latin American countries. In response to this demand, brief treatises were written by members of the staff, covering the effects of the war on exchange in Brazil, Uruguay, Argentina, and Chile. The published portion of these studies received the commendation of economic authorities to whose attention they were brought.

Data on Latin American newspapers and suggestions regarding effective propaganda methods in that region were supplied to the Committee on Public Information. Work was also done toward securing for that body the private cooperation of American business houses established in Latin America.

Investigations were conducted regularly for the Foreign Trade Adviser's office of the State Department with a view to supplying economic material that might be useful in diplomatic negotiations with Latin American countries.

As early as May, 1918, the Latin American division was called upon for cooperation in collecting economic data for use at the Peace Conference. In fact, some time before the signing of the armistice a special expert was employed by the Col. House inquiry to take charge of these investigations in the Latin American division.

A number of manuscript reports were transmitted to the inquiry for the files of material to be used by the American delegation at the Peace Conference.

### TRADE-INFORMATION SERVICE DURING WAR PERIOD.

While the time of the Latin American division was primarily occupied with the war activities above enumerated, the work of supplying trade information to private interests was not neglected. In fact, while working hand in hand with Government war organizations, the division was often called upon to exercise its functions as advocate of private business by such services as it might render to exporters whose business was subject to war-time restrictions and control. In this way the division was forced to act as a mediator between opposing interests and to exercise tact and ingenuity in rendering what assistance it could to private business while pointing out the primary importance of the observance of the policies of war boards.

### WORK OF DIVISION SUBSEQUENT TO SIGNING OF ARMISTICE.

The tremendous revolution in business that took place after the cessation of hostilities was faithfully reflected in the work of the Latin American division. Activities entailed by war conditions, which had been all important up to this time, came to an end, and an intensely interesting condition of affairs ensued as the manufacturing industries of the country turned to foreign markets as outlets for their production. A fairly accurate measure of business interest in Latin America as an export field is given by the number of letters of trade information written weekly by the division, in response to inquiries received from business houses. The following table shows the average number of such letters written weekly by the division during the year: July, 89; August, 71; September, 92; October, 105; November, 109; December, 124; January, 196; February, 161; March, 171; April, 220; May, 190; June, 130.

### PERSONAL CONTACT WITH BUSINESS MEN.

Besides the increased volume of trade information furnished by correspondence, there developed a very noticeable advance in the personal contact of this division with business men. The number of visits made by export managers, salesmen, and officials of manufacturing firms and export houses, grew to 35 or 40 weekly. Many salesmen about to make a Latin American trip have spent from one to three days in the division in a study of matters pertaining to their particular work.

### CHARACTER OF BUSINESS HOUSES KEEPING IN TOUCH WITH DIVISION.

One of the most encouraging and promising features of the trade-promotive work of the Latin American division has been the regularity with which its services have been used by business institutions recognized as among the most important in the country. Among them may be mentioned practically all the American banks that have branches or affiliated houses in Latin America, the more prominent steel companies, many of the strongest export and import houses, investment and financial institutions, and many others among the leaders in their respective industries, such as textiles, chemicals, paints and varnish, jewelry, rubber, motor cars, agricultural implements and machinery, industrial equipment, railway supplies, electrical manufactures, explosives, timber, hardware of all kinds, construction materials, foodstuffs, and, in lesser volume, practically every variety of manufactures.

### WORK FOR OTHER GOVERNMENT OFFICES SINCE TERMINATION OF HOSTILITIES.

The place of the Latin American division as a fundamental source of economic knowledge of Latin America, and the value of having available an official collection of data of this character, are demonstrated by the continued use made of this office by other branches of the Government. Such recognition is due to the services of the division during the period of the war, as mentioned earlier in this report, and such activity promises to be a permanent part of the functions of the division. Among the official and semiofficial organizations that are using the facilities of this division with regularity are the following:

*State Department.*—Foreign Trade Adviser's office: Statistics and reports of the field agents of this Bureau.

*War Department.*—Military intelligence division of the General Staff: Latin American trade statistics, ports, roads, vital statistics, armies, and navies. Aviation Service: Development of aviation in Latin America.

*Navy Department.*—Naval intelligence division of the Bureau of Naval Operations: Trade and vital statistics, ports, aviation. Communications service: Developments in radio telegraphy in Latin America.

*Treasury Department.*—Data on exchange in Latin America, Government finances and resources.

*Department of the Interior.*—Bureau of Mines: Data on Latin American mines and minerals.

*Department of Agriculture.*—Bureau of Plant Industry: Latin American flora. Forest Service: Latin American timber and industrial development. Bureau of Markets: Commodity prices and general agricultural data.

*Department of Labor.*—Division of public works: Latin American industries and labor conditions.

*Federal Reserve Board.*—Data on exchange fluctuations and government finances in Latin America.

*Federal Trade Commission.*—Export trade division: Trade disputes.

*Pan American Union.*—Latin American trade information.

*Panama Canal.*—Data on sugar and other tropical products.

*Red Cross.*—Information on West Indian islands.

*Smithsonian Institution.*—Geological data.

*Shipping Board.*—Information on Latin American raw products, merchant marine, ports, harbors, navigation laws, prewar freight rates, European competition, and labor disturbances.

*International High Commission.*—Latin American commercial laws.

*Chamber of Commerce of the United States.*—Latin American commercial organizations and arbitration of trade disputes.

### METHODS OF ACCUMULATING ECONOMIC DATA.

The division derives its file material from the following sources: Daily newspapers from Latin America and Great Britain, and commercial journals printed in the United States; weekly and monthly periodicals published in Latin America, Europe, and the United States that contain anything affecting Latin American resources and commerce; the consular and diplomatic reports received through the Department of State; the reports of this Bureau's commercial attachés and trade commissioners in Latin America; official reports and statistical compilations of Latin American Governments; miscellaneous pamphlets and books containing pertinent material collected by the field agents of the Bureau or purchased for the use of the division; correspondence with business houses and individuals that have a first-hand knowledge of Latin American affairs.

The newspapers received by the division, from which are clipped all articles of value for the division files, are kept to as small a figure as is consistent with the proper covering of the field, because of the time necessary for their perusal. As to language, they are divided as follows: Spanish, 36; Portuguese, 4; French, 2; English, 13; total, 55.

The magazines received in the division are not clipped, but are read and articles of value are indexed in the division's index files, while the magazines themselves are put where they may be available for quick reference at any time. The weekly and monthly periodicals received are divided by languages, as follows: Spanish, 78; Portuguese, 14; French, 6; English, 62; total, 160.

The clipping and index files of the division are identical in topics and classification. They comprise 158 major subjects, under which all economic material is filed. Each major subject is subdivided by countries and colonies, making a total of such classifications of 21 to 28 under each major topic.

### ORIGINAL RESEARCH WORK.

So far as the time necessarily occupied by work of prior importance has permitted, the division has attempted to prepare articles of original research on subjects of timely interest. These brief reports, to which the name of Latin American circulars has been given, were issued during the past year at intervals of approximately two weeks and are being published in Commerce Reports. During the past year, the series has included reports on the trade balance and foreign exchange of Uruguay and Brazil; railways and railway development in Mexico, Brazil, Peru, and Argentina; petroleum and general trade conditions in Mexico; paint and varnish and automobile markets; and other miscellaneous subjects of interest at the time. A gratifying appreciation of this side of the division's work has been manifested by the reprinting of such studies in trade journals and the daily press. The editor of the Economic World, of New York, wrote the division as follows, under date of September 25, 1918:

> I can not refrain from saying to you that, of all the material reaching me from Washington at the present time—and the amount of this material is enormous—none seems to me to have the solidity and economic soundness of the material which is being prepared by the Latin American division of the Bureau of Foreign and Domestic Commerce. It is genuinely enlightening and quite free from the loose exaggerations which are only too common in the outgivings of many of our enthusiastic propagandists of a world easily conquered by the wealth and productive power of the United States after the war. Personally, I feel that I owe a good deal to the Latin American division for what it has already done, and I know that many readers of the Economic World feel precisely as I do.

Mr. Edward L. Doheny, the discoverer of petroleum in Mexico, wrote as follows, under date of October 7, 1918, with reference to Latin American Circular No. 45, on the Mexican petroleum situation:

> I desire to congratulate you upon the accuracy of all the facts stated in your circular (No. 45, Mexican petroleum situation), and to commend the way in which you have arranged them and treated them.

As the files of the division are enriched by the addition of new material and the acquisition of anything of value that is found available, it becomes evident that a great deal of data of interest and importance can be prepared in the division and issued in the form of a Latin American circular, thus presenting to American business men material of value at a comparatively slight expense.

### WORK IN RELATION TO LATIN AMERICAN TRADE EDUCATION.

During the last week of the year the division prepared a complete syllabus for the use of instructors in Latin American trade courses and of students who desire to pursue such study independently. This work comprises four courses on the main divisions of Latin America, including preliminary references to history and the social heritage of each nation as well as reviews of the physical features, transportation, native products, banking and finance, and economic characteristics peculiar to the given region. Commodity studies based mainly on the official reports issued by this Bureau form the practical end of each course. This syllabus will be embodied in a bulletin to be issued by the Federal Board for Vocational Education about the first of September, 1919.

### FAR EASTERN DIVISION.

The American business man entering the Far Eastern field is confronted by many conditions that, at first, seem strange, incalculable—the fruits of a civilization that for thousands of years progressed on lines diametrically opposed to those to which he is accustomed—conditions that have persisted in spite of the advancement during recent years. Facile adaptability to novel methods and alien viewpoints is almost indispensable if he is to succeed. To supply such information as will minimize the obstacles and enable American manufacturers to cultivate this great field with effectiveness and skill, is the function of the Far Eastern division of the Bureau of Foreign and Domestic Commerce.

It has been clearly perceived that the work of the division lies along two broad general lines—(1) the accumulation of trade information and (2) its effective distribution; and in order that the division should function properly, it is not desirable for either of these to be extended beyond the capacities of the other.

### ACCUMULATION OF DATA.

It was soon found that the accumulation of data of a certain character could be easily reduced to a matter of routine. This included, first, clippings from trade papers. Practically all of the important and some of the unimportant English Far Eastern trade papers were being received, and, by eliminating some of the latter and greatly extending the former, the present list of about 30 representative publications was obtained for regular clipping service, from which about 100 clippings are made each week. The question then arose of how to give the live and pertinent information contained in these clippings the widest circulation, and a plan of making a weekly digest of them for publication in Commerce Reports has proved a happy solution. These "Press Notes" are widely copied in trade and news papers in this country and have done as much as any single medium toward gaining wide circulation for the data in the division's files. The value of directing intelligent inquiry in this manner is manifest, in that it discourages the old type of "drag-net" inquiry (which is so difficult to handle) and directs the attention of the merchant and manufacturer to available material of a specific nature, which is much more likely to have beneficial results.

The duplicate replies of consuls to trade inquiries have formed a source of invaluable information of a compact and readily available nature. The question of how to use this information was largely one of proper classification and accessibility. These letters are now filed in the Far Eastern division rather than in the editorial division, and their gist is summarized on cards filed by commodities. Letters of special merit form the nucleus of special articles in Commerce Reports under the heading "Far Eastern Trade Notes."

The reports of commercial attachés, trade commissioners, and special investigators offer by far the most reliable and pertinent sources of information, as they are designed to meet exactly the requirements of the Bureau. In suggesting the lines that these reports should follow, commending good work, and calling attention to faulty work, the division has been able to improve in many instances the quality of the work turned in. Emphasis has been laid on the value of short, complete reports on subjects of immediate interest. When longer reports have been submitted by special investigators, forming part of their monographs, these have been summarized for publication in Commerce Reports. Special lines of investigation for commercial attachés and trade commissioners have been suggested in accordance with the demand evidenced by inquiries from American sources. Short paragraphs from weekly reports of these officials have been included in the "Far Eastern Trade Notes" or worked up into special short articles for Commerce Reports. It is believed that in this work the foundation of a really effective trade-information service has been laid.

Valuable material has been gathered from many other sources to supplement the files of the Division. Yearbooks, directories, books on economic conditions, official reports of foreign Government bureaus and departments have expanded the book shelves of the division from 4 to 15 sections. These have not only been indexed in the Department library, but have been carded in the division, and notice of their receipt has been published in Commerce Reports. The sources of the annual publications have been ascertained and arrangements made for the regular receipt of these in the future. The staff of the division is gradually becoming more familiar with these sources of information, and they are constantly utilized in answering inquiries.

### TRADE-INFORMATION SERVICE.

In the distribution of the material thus accumulated, probably two-thirds of the effort has been expended in answering individual inquiries. These have increased from about 25 per week in July, 1918, to more than 125 per week at the present time. The average American business man seems to have only a vague idea of the Far Eastern field, and a good deal of primary educational work has been necessary. In the very few instances, however, where large manufacturing interests maintain Far Eastern organizations, much use has been made of the material available in the division. The rule in answering all inquiries has been to comb every source of information in order to get the exact data required. In a surprisingly large number of cases this is completely successful. The handling of these inquiries has been placed to the fore as the most important single function of the division, and no other work is allowed to detract from the attention bestowed upon them, as it is realized that only in this way can we be assured of really effective results.

The district offices have been encouraged to pass on to the division difficult requests regarding the Far East for a possibly fuller treatment than the limited material at their disposal may permit. This serves the double purpose of more effective distribution and of completing our district office files.

Lists of selected titles are now being prepared from the division's clipping files and card index of articles in periodicals, and a questionnaire to all of the libraries and chambers of commerce in the country has furnished a complete list of places where Far Eastern periodicals are available. As these selected title lists become very soon obsolete, no attempt will be made to mimeograph large numbers, but typewritten copies, prepared in response to special inquiries, will be reproduced by the photostat process and distributed to district and cooperative offices.

It was early discovered in mapping out the work of the division that there was a steady call for comprehensive surveys of the Far Eastern markets for certain articles entering largely into American export trade. To meet this demand 18 circulars on the opportunity for such goods in practically all important Far Eastern markets have been prepared and given wide circulation through Commerce Reports and a special Far Eastern mailing list comprising practically all American exporters and manufacturers actively engaged in Far Eastern trade. These circulars have had gratifying results, have been widely copied by trade and news papers, and have been a valuable means of advertising the services that the division is prepared to render.

In addition to these more lengthy studies, much material of immediate interest has passed through the division that is not in such shape as to be readily usable in Commerce Reports. These data are combined and rewritten in the form of special articles and as such are given the same publicity as circulars. Many inquiries for more specific information are directly traceable to these special articles.

Articles on Far Eastern trade have been prepared and published in The Nation's Business, Automotive Industries, the New York Sun, and other organs and have attracted wide attention to the work of the division. Syndicated articles for the Philadelphia Public Ledger, the Haskin Syndicate, etc., have also done much to call attention to the Bureau's Far Eastern activities.

### MISCELLANEOUS ACTIVITIES OF DIVISION.

The miscellaneous activities of the division during the year have been numerous and exacting.

Early in the fiscal year it was called upon for advice regarding the desire of the Chinese Government to purchase railway equipment immediately; and the matter was handled up to the point of actual financing when the end of the war brought about certain developments in the formation of the American banking group which eclipsed the immediate urgency.

A little later our bill for the incorporation of companies engaged exclusively in foreign trade was introduced in Congress. This was designed primarily to permit the incorporation of American companies in China (where the United States exercises extraterritorial jurisdiction) under American Federal law, so as to put them on an equal footing with British and other companies that take advantage of the very favorable Hongkong Ordinances. This bill received a hearing in both houses of Congress but died with the session ended March 4, 1919. It has now been reintroduced in more acceptable form and is expected to pass.

The subject of better cable facilities across the Pacific has received a great deal of attention from the division. Early in May a conference was held in conjunction with the Bureau of Standards and the Industrial Cooperation Service on the all-important subject of a necessary supply of gutta-percha for cable construction, which was followed later by the appointment of a standing Bureau committee on cables. A memorandum drawn up by the Far Eastern division was incorporated in the recommendations that the Secretary of Commerce sent to the Senate Committee on Commerce in reference to Senator Jones's bill for the creation of a Pacific cable commission and the laying of an American cable to the Far East. The division has also used its good offices with the chief cable censor of the Navy in straightening out many difficulties resulting from the extension of the Navy wireless to commercial use. A complete résumé of the cable situation is soon to be published as a Far Eastern circular for the benefit of American business interests.

At the request of the Shipping Board the division has been called upon to suggest several routes for a trans-Pacific steamship service. This has entailed a great deal of research into the movement of commodities not only to and from the Far East, but also from one Far Eastern port to another. After much careful consideration two routes have been suggested, and the suggestions have been supported by full facts regarding port facilities, return cargo, and possible development of markets.

The division has been called upon frequently to clear up trade disputes of a peculiarly aggravated nature. In one instance the complaint was lodged through the Philippine government against certain American exporters of stationery, and after full investigation the division was able to put the matter in such a light as to justify the action of the American exporter, whose only fault was an overanxiety to act in the best interests of his foreign customer. In another instance a shipment to the Dutch East Indies was sold at a delivered price and the freight prepaid, but, because of the exigencies of war, over which neither party had any control, a transshipment was necessary at an additional charge to the purchaser. Although the American shipper was legally exempt from this loss by the terms of his contract, the division was able to convince him that it was to his ultimate advantage to handle the claim on the steamship company, which he consented to do. Again, where an American exporter obtained a Malayan agency for an American product in order to protect the interests of his Malayan agents the action was misunderstood by the foreign firm, which had explicitly requested the American exporter to have the agency contract made out in the name of the Malayan firm. The letter sent by the American exporter was not well expressed and conveyed a wrong impression, which, when it was called to his attention, he was quick to remedy to the satisfaction of all concerned. In numerous other instances, only a little tact and good judgment were needed to straighten out a situation that contained the seeds of very serious misunderstandings and that would have been gravely detrimental to American commercial interests in the Far East.

The division has been requested from time to time to assist American exporters and manufacturers in getting passports and permits for their employees to travel in the Far East. In one or two cases where men of a certain training were absolutely essential to the building up of the company's trade in the Orient, the persons selected were denied egress from the country because of suspected enemy sympathies. In such cases the division has endeavored to influence the officials in charge to make the investigation of each case as thorough as possible, running down and either proving or disproving the allegations. In several cases this method has resulted in dispelling many of the suspicions, and thereby removing a serious drawback to the successful promotion of American trade in the Orient.

Talks before trade bodies have constituted one phase of the activities of the personnel of the division, and these have afforded very helpful opportunities of coming in contact with organizations working along similar lines.

### PLANS FOR INDEX AND TRADE LISTS.

The material now on hand and coming in from the Far East is too voluminous to be handled entirely in the ways now being utilized. The division intends to complete its index of American firms actively interested in oriental trade, both importers and exporters, and to distribute "photostated" material widely to these firms. It is found that unsolicited information of this kind is very gratefully received.

The division's multigraphed trade lists of foreign firms are constantly becoming obsolete and, when furnished to American merchants in touch with oriental trade, sometimes create an unfavorable impression. Many of the letters from Far Eastern consuls, as well as status reports, etc., received by the commercial intelligence section, contain trade lists that are up to date but can not be multigraphed; these are to be carded as "Foreign exporters" and "Foreign importers" and made the basis of an elastic file that can be checked and kept up to date easily. The lists will be merely typewritten from them in lots of 5 or 6 copies, so that obsolete multigraphed lists will not have to be used, and the typewritten lists will be used up before they become out of date, while the new ones prepared will be constantly improved.

## RUSSIAN DIVISION.

The organization of a Russian division in the Bureau was brought about in January of this year, following the return to the United States of the Bureau's commercial attaché to the American Embassy in Russia, William C. Huntington, after an experience of more than two years in European Russia and Siberia. Such a genuine and widespread interest in Russia was encountered in business circles that the Bureau deemed it necessary to meet this demand by the organization of a modest Russian division, of which the attaché was placed in charge as chief. The staff now consists of the chief and three assistants, carefully chosen as to their competence in order to guarantee accuracy and thoroughness.

In spite of all disappointments, the interest of modern American business men in Russia continues very keen. They feel instinctively that a country nearly three times the size of continental United States, with a population almost twice as great as ours, composed essentially of sound white stock, must eventually present great business opportunities. Russia is a unique source of raw materials—food, flax, hides and skins, fur, timber, petroleum, manganese, and platinum—and we are living in an age of raw materials, which exhausted industrial countries are everywhere seeking. But, even more than this, the great basis for a vast future market in Russia is afforded by the rapidly developing producing and consuming capacity of its tremendous population, held back by a combination of natural and political circumstances, and now, as a result of the great war, launched upon the current of the modern world and endeavoring to catch up with other nations.

The Russian division has abstained conscientiously from any illusions as to the difficulty of the present trying conditions. It is firmly persuaded, however, that strong and well-organized American concerns, which look upon world trade from a statesmanlike point of view, should be hard at work studying Russia.

The present transitory period can be made of real advantage if it is utilized to develop the knowledge and organization which are essential in order to seize the opportunity for large-scale business the moment the way is opened.

The aim of the divison is to make a thorough economic study of Russia and to build up a rich fund of sound, tested information in its collation file and library; on the basis of personal experience in the field and of this information, to furnish reliable and accurate data to our business interests; to become a recognized center for sound and sympathetic interpretation of economic Russia, and thus to aid in Russian reconstruction.

The work is carried on chiefly by a wide correspondence in which multifarious inquiries from business concerns are answered. Sometimes these inquiries demand so much research and the matter is of such general interest that the whole is worked up into an article for publication in Commerce Reports. The division has prepared numerous articles and translations for publication in Commerce Reports—on Russian currency; mineral resources; the market for textiles and clothing; the flour-milling industry; the beet-sugar industry; the port of Archangel; the resources and trade possibilities of

Poland, etc. The chief of the division has prepared a number of magazine articles, and has come into personal contact with many business organizations by making about 25 principal speeches in various commercial centers.

A great deal of time and pains has been devoted to callers and personal interviews. Many business men, both American and Russian, have visited the division.

The Russian cooperative societies and their projects have taken much time, and in dealing with them the division has been of special service because of the fact that for a long time after his return the chief was the only official in Washington who had had previous dealings with these organizations in Russia and a personal acquaintance with their leaders. The Russian cooperative societies rest on a firm democratic foundation, are very widely developed, and are destined to play a large rôle in the development of Russian economic life, particularly in the realm of distribution to the peasant millions.

The division participated in an advisory capacity in the conferences between the War Trade Board and the cooperative societies, which resulted in the granting by the War Department to the cooperative societies of a merchandise credit of about $20,000,000 in the form of certain staple supplies from the surplus stocks of the War Department, which will greatly relieve the needs of the population in the wide areas of Russia.

In order to give complete answers to its inquirers, the division has made efforts to obtain publications from all sources and has worked in close cooperation with other divisions of this department, as well as with the Department of State, the Department of Labor, the Shipping Board, and the War Trade Board. It regularly exchanges material with these other Government departments. It has cooperated also with the military intelligence division of the War Department.

The division has also cooperated closely with such organizations as the American-Russian Chamber of Commerce, the Russian-American Committee for the Far East, the Russian Embassy, the consulate general of the Republic of Poland, the Russian Economic League, the American Committee of Russian Cooperative Unions, the Union of the Siberian Creamery Associations, the United Credit Unions of Siberia, the American Manufacturers Export Association, and various chambers of commerce abroad, in Harbin, Omsk, and Archangel. The division has made arrangements with the State Department to obtain periodically data from representatives in the United States of States newly organized from parts of the former Russian Empire.

The greatest need of American business in Russia is a staff of trained men who know the country and at least in some measure speak the language. The Russian division has personally conferred with many young Americans endeavoring to facilitate their studies, and is gathering a list of responsible Americans, with some Russian training, who would be eventually available for doing business with Russia. A list of books and pamphlets on Russia has been printed, and a complete tentative study outline prepared, covering the commercial area of the former Russian Empire, for the Federal Board for Vocational Education.

The Russian division, in coordinating authentic information about Russia, is bridging the period when normal business is largely checked. As conditions become more stable, its functions will become constantly more important.

## DISTRICT-OFFICE SERVICE.

District offices of the Bureau have been maintained during the entire fiscal year at New York, Boston, Chicago, St. Louis, New Orleans, San Francisco, and Seattle, and cooperative offices at Cleveland, Cincinnati, Philadelphia, Los Angeles, Portland, Oreg., and Dayton.

The work of the Bureau's district offices during the past fiscal year should properly be divided into two parts—the work performed during the war and that undertaken after the armistice. As the district offices have long since justified their existence and demonstrated the wisdom of their establishment, they are obliged no longer to confine their activities to the "missionary work" of acquainting business men in their respective territories with the character of the service furnished by the Bureau of Foreign and Domestic Commerce. The lessening of this type of work has left more time for practical work of a constructive nature.

The work for the fiscal year ended June 30, 1919, was, therefore, largely constructive, and the personnel of the various offices was kept busy long after working hours every working day of the year helping to solve the various problems of firms interested in foreign trade. These problems covered such questions as markets, foreign tariffs, shipping facilities, the financing of foreign trade, port facilities, export technique, war regulations, customs procedure, and the thousands of other practical questions that present themselves daily to the importer and exporter.

### WORK IN CONNECTION WITH WAR-TIME RESTRICTIONS.

The past year has witnessed a gradual reorganization of a system of licenses and embargoes that had held in restraint for several years the commerce of the entire world. It has also seen the rise of individual commercial aggressiveness as distinguished from governmental control and operation in the various branches of trade.

While the actual handling of export and import licenses was taken out of the hands of the district-office managers long before the beginning of the fiscal year, nevertheless many inquiries were received regarding the war regulations and limitations of both the United States and foreign nations. The district-office managers were very active in the explanation of these Government restrictions to the business men affected, and in cooperating with other governmental agencies toward the proper enforcement of their decrees. It is estimated that approximately 25 per cent of the time of the district-office employees was taken up with this class of work until the signing of the armistice. After the signing of the armistice changes in regulations occurred with great frequency, and it became an essential part of the work of the district offices to keep business men informed of these changes and their probable effect upon our foreign trade.

### CHANGE IN ACTIVITIES AFTER SIGNING OF ARMISTICE.

Immediately after the signing of the armistice, a great change took place in the foreign-trade activities of this country. This change had been anticipated with no small degree of apprehension by our district-office managers, largely because of the fact that the offices were insufficiently equipped in the way of clerical assistance to handle the many inquiries that poured in constantly, following the cessation of hostilities. Urgent demands were received from business men for unlimited advice and assistance relative to the new markets opened to them. The extremely small staffs of the various offices responded admirably with the facilities at their disposal. Yet, unfortunately, they were pitifully inadequate to cope with the calls made upon them.

The development of industrial plants in this country during the war, and the cancellation of war contracts after the cessation of hostilities, left American business men in a very unsettled condition. The advice of the district-office managers was constantly sought as to the best methods of keeping these industrial plants going and the most accessible markets for their output. It is gratifying to note that the district-office managers responded in a most satisfactory manner, and the expressions of appreciation received from the business men who took occasion to make use of this service testify to the value of the information and advice furnished.

### SPECIAL ATTENTION GIVEN TO FOREIGN BUSINESS MEN.

Another important feature of the work of these offices showed a remarkable development immediately after the signing of the armistice and has continued until the close of the fiscal year—namely, the arrival in this country of a comparatively large number of foreign business men desiring to be placed in touch with American manufacturers and exporters. The war work performed by the offices in the previous fiscal year acted as an excellent advertisement, though the limited staffs unfortunately were unable to take full advantage of this situation. It is probably because of this publicity, however, as well as the increasing number of firms entering the import and export business, that the work of the district offices has increased so materially. Special attention has been given to these foreign business men, and, with the assistance of foreign-trade-opportunity announcements published in Commerce Reports, the district offices have gained a reputation for meeting fully all the numerous and varied requests for assistance of this character.

### ADJUSTMENT OF COMPLAINTS.

Another important feature of the work of these offices is the adjustment of complaints arising from transactions between merchants in this country and their foreign customers. These complaints cover a variety of commodities and result from multitudinous causes. It has been a source of great gratification, however, to learn that through the efforts of our district-office managers and their assistants the majority of these complaints have been adjusted (without recourse to legal procedure) to the entire satisfaction of all parties involved. This work has increased to such an extent that in the New

York district office alone the entire time of one commercial agent is taken up in this class of work, and it is with difficulty that he is able to keep abreast of the demands made upon him.

### PLACING BUSINESS FIRMS IN TOUCH WITH COMPETENT MEN.

In addition to the activities already outlined, there might also be mentioned one phase of the work which is really more of a personal service, but which, nevertheless, has accomplished some excellent results in the way of placing applicants with firms engaged in foreign trade and in supplying appreciated service to the large trading companies and export houses by putting them in touch with valuable men. This was no small task during the early part of the fiscal year, when there was a shortage of man power, and it became a still greater task when, after the signing of the armistice, a large number of returned soldiers and sailors were seeking positions. Records are kept in the district offices of applicants with various qualifications who have submitted statements outlining their education and experience and have furnished other evidences of ability to perform work of this character. The district-office managers have been instrumental in serving many business firms by placing them in contact with applicants possessing the qualifications desired by such commercial houses. Several large foreign-trade companies have been assisted in securing the managers of their foreign branches through this personal service on the part of the district offices. The district-office managers have been advised by the heads of these firms that the employees so placed have been entirely satisfactory thus far. It is obvious that, with the intimate knowledge which the district-office managers have of business houses in their districts and the qualifications of the various applicants for positions, they are peculiarly competent to render effective service of this kind.

### DISTRIBUTION OF INFORMATION.

The constructive work of the district offices of the Bureau divides itself logically into the following branches: Educational; conferences in the district offices; official investigations; committee meetings; publicity; and distribution of Bureau publications and literature.

One of the first concerns of the district offices is to see that information of the Bureau (in the form of special publications, regular publications such as Commerce Reports, reserved information from foreign-trade-opportunity announcements, and trade lists) is distributed to the fullest extent and to the greatest possible advantage. That this work is performed in a satisfactory manner is evident from the fact that the sales of Bureau publications in one office alone are running well over $500 per month. The requests for reserved information from foreign-trade announcements in the same office have increased to an average of approximately 7,500 per week at the present time, as compared with an average of about 2,000 maintained a year ago.

While this class of work may seem routine, it has become so thoroughly systematized by the Bureau's instructions that it has been accomplished with as little detail as possible. Nevertheless, there are many features of this service that score heavily in commercial results, if it be handled by an experienced office manager thoroughly familiar with the trade in his territory, as is evidenced by the number of commendatory communications received from clients, and transmitted through these offices to the Bureau from time to time, regarding commercial orders received and contracts consummated. The correspondence conducted by the various district offices naturally falls within this branch of constructive work, and the number of letters received and handled by the various offices during the past fiscal year has increased approximately 200 per cent.

### EDUCATIONAL WORK.

The educational work of the district offices consists largely in addresses before schools, educational institutions, commercial organizations, and similar bodies. As a matter of course, the addresses must be prepared with a view to their adaptability to the type of listeners and to the occasion upon which they are delivered. The various district-office managers have specialized in this class of work during the past year, and some of them have delivered as many as a hundred addresses of this character.

The district-office managers, almost without exception, conducted classes in foreign trade, with an attendance averaging several hundred in each class. Members of these classes in most instances were not merely beginners, but were persons actually engaged in foreign trade, many of them being managers of foreign departments of large concerns and in some instances the heads of the concerns themselves. These classes extended over a period of several months and were conducted under the auspices of universities or commercial organizations. Besides the general instructions given on shipping, financing, importing and exporting, trade technique, political economy, and commercial geography, time was found to outline the sources of information and explain in detail the work of the Bureau. As a result of this particular class of work, not only were many publications of the Bureau sold to these students in foreign trade, but they were also used as textbooks, and a thorough explanation of the contents was made. A bibliography of other publications of the Bureau was given, and in this way the work of the Bureau was made known to a large number of business men who otherwise would not be familiar with this detailed information in the possession of the Bureau and its district offices.

"Round tables" were conducted by commercial organizations in many of the cities, and the district-office managers coöperated fully with these organizations, taking a prominent part in the discussions. At these meetings the various features of foreign trade were discussed by experts in their respective fields, and the large attendance at such discussions and the practical information imparted were sufficient evidence of the effectiveness of the plan.

### IMPORTANCE OF CONFERENCES AND COMMITTEE MEETINGS.

By far the best results in constructive work were obtained through the conferences in the Bureau's district offices and the committee meetings of various organizations of which the district-office managers were ex officio members. These conferences, as a rule, were not confined to merely answering queries that could just as well be answered by telephone or by a few dictated sentences, but in most instances penetrated into a discussion of the details of various phases of foreign trade. Some of the topics may be mentioned, as samples of the subjects that were discussed by heads of important concerns who visited the various district offices; they included such questions as port facilities, the advantages of free ports, the importance of standardization of weights and measures, through bills of lading and their effect on foreign trade, cable facilities, and the plans of various Federal departments toward financing foreign trade. The conferences in one district office, for instance, have increased to a point where it is idle to compare them with anything that has gone before, there being an average of well over 500 per week. These conferences are of the highest importance, and there has been a most marked change to conferences wherein advice is requested rather than merely information. This advice is desired upon practically every feature of foreign trade, from financing to the question of prices and the routing of commercial travelers.

Not infrequently visitors to the district offices seek specific information that is not altogether along foreign-trade lines. Others are much interested in the manufacturing activities and resources of certain specified sections of the United States or its possessions and desire all the details in regard to them. For instance, one concern contemplating sending a representative to the Philippine Islands was not satisfied with a brief summary of the possibilities, but required several hours (at different times) of research as well as considerable correspondence with respect to the facilities for pineapple raising, the advisability of manufacturing furniture and shipping it to the United States, and the possible opening for the manufacture with native labor of men's ready-to-wear apparel for the oriental trade.

The committee meetings bring out the importance of close contact with the various commercial organizations in the respective districts assigned to district-office managers, and the coordination of them in the work of developing commerce.

During the past year many foreign-trade clubs were organized by the district-office managers, and the managers not only participated in the various discussions, but practically directed the work of these organizations during the early days of their life.

### ARTICLES AND INTERVIEWS IN DAILY AND TRADE PRESS.

The publicity work of the offices was necessarily limited by the personnel that the Bureau was able to assign to each office. In addition to the regular weekly service, which several of the offices inaugurated some time ago, of furnishing to a leading daily paper questions and answers on foreign-trade subjects, which has attracted wide and favorable comment throughout the districts, the managers are frequently called upon to contribute special articles for leading daily and trade publications. Hardly a day passes that interviews with district-office managers on special occasions and dealing with specific subjects are not printed in the daily and trade press.

### RESULTS ATTAINED BY COOPERATIVE OFFICES.

It might not be amiss to give brief mention to the cooperative offices that have been established in commercial organizations in eight cities because the funds of the Bureau were not sufficient to permit the establishment of additional district offices. These cooperative offices are furnished the same information as the district offices and perform identically the same service for the business men in the cities in which they are located, the only essential difference between them and the district offices of the Bureau being that the expenses of the cooperative offices are defrayed by the commercial organization in which the office is located, while the expenses of the district offices are met by funds appropriated by Congress. These cooperative offices have functioned very well since their creation, and have enabled the Bureau to obtain a wider distribution of its information and an extension of its service to the business men who can not be as quickly reached by the Bureau or its district offices. Correspondence has been conducted with a number of commercial organizations in cities where the Bureau has no direct representation at the present time, and it is probable that several additional cooperative branch offices will be established during the coming fiscal year.

### NOTABLE WORK ACCOMPLISHED WITH INADEQUATE RESOURCES.

During the past fiscal year there were no changes in the number or location of the district offices, but the changes in personnel were very frequent and in many cases sudden. This is due to the unfortunate condition in which these offices are placed through lack of sufficient funds to equip them properly in the matter of employees, as well as physical requirements for properly conducting their work. In several of the larger and more important offices it was necessary to change the district-office manager several times during the course of the fiscal year, and this condition will necessarily exist until the Bureau receives sufficient funds to enable it to pay the men in charge of such important work salaries commensurate with the services performed. These men at the present time receive salaries much lower than those paid to men performing similar work for commercial organizations and private concerns, notwithstanding the fact that they are recognized leaders in their communities on foreign-trade subjects of every character.

In conclusion, it may be stated that these district offices have fulfilled their functions in a most satisfactory manner during the past fiscal year. The district-office managers have discharged with faithfulness and intelligence the duties imposed upon them, and it is hoped that sufficient funds may be provided to enable these offices to comply with the ever-increasing requests made by the business men whose requirements they are meeting and whose demands are daily becoming more exacting.

## DIVISION OF FOREIGN TARIFFS.

### GREAT INCREASE IN CORRESPONDENCE.

The work of the division of foreign tariffs during the past year has been characterized by the expansion of the correspondence at the expense of publication. While under normal conditions the publication work takes up nearly half the time of the division, during the last year that work had to be subordinated, to a very large extent, to the rapidly growing correspondence, dealing primarily with the multitudinous war restrictions on commerce in foreign countries. The increase in the division's mail was particularly noticeable after the armistice, when it rapidly reached a monthly average of nearly 1,000 letters, as compared with an average of less than 250 during the preceding year. Inquiries regarding foreign rates of duty, which predominate under normal conditions, were comparatively few, probably because of the fact that the great demand for American goods on the part of foreign consumers made the American exporter rather indifferent as to the import duties to be paid by the importer. The import restrictions, on the other hand, constituted a very serious obstacle to export trade and it required a considerable amount of ingenuity and diplomacy to get the average exporter to see the broader problems of exchange, international commercial policies, and national interests involved in the import prohibition on the particular article in which he was interested. There has also been a considerable increase in the correspondence dealing with foreign trade-mark legislation and parcel-post facilities—the latter a comparatively new subject for the division.

### FOREIGN TRADE-MARK LAWS.

The work of the division in connection with foreign trade-mark legislation, and particularly with examination of official publications with a view to detecting attempts to pirate American trade-marks, has been considerably extended and has resulted in a number of very desirable new connections among American firms. In some cases, where promptness was highly essential, telegrams were sent to the district offices for transmission to the firms located in their cities.

In one particular case, involving a very valuable general trademark used by a prominent drug firm, the information was sent by wire to one of the Bureau's district offices and transmitted by telephone to the firm a few hours after the information had reached the Washington office. The firm acknowledged the service rendered by the Bureau in the following statement: "We certainly appreciate the wonderful system you must have to keep track of these things and to notify the proper party interested." While there has been no definite legislation in Latin American countries intended to discourage the appropriation of foreign trade-marks, some of the court decisions would indicate a tendency to recognize the unfairness of such practices. The informal opening of the Habana bureau for the registration of trade-marks in the northern group of countries adhering to the Pan American Trade-Mark Convention has aroused considerable interest among American firms, and while the Bureau has not yet been officially recognized by adequate legislation in the United States, it is understood that many applications have been transmitted through the United States Patent Office. In addition to following the trade-mark legislation of foreign countries and sending out warnings in cases of attempted piracy, the division has also succeeded in assisting American firms to recover trade-marks that had been appropriated by their agents some time ago. The trade-mark legislation of the new States is a subject to which the division plans to devote considerable attention, especially since there has been discovered in the case of some of them a tendency toward premature autonomy that may result in the loss of some valuable trade-mark rights by such firms as may not keep in touch with new trade-mark legislation.

### PUBLICATION WORK.

The rapidly growing correspondence and the necessity of devoting more time to the complicated war restrictions on commerce in belligerent as well as neutral countries have practically restricted the publication work of the division to the current notes and cables prepared for Commerce Reports and later reprinted as Foreign Tariff Notes. In addition, the division prepared a supplement to Tariff Series No. 39, dealing with changes in British trade restrictions, and edited the translation of the customs tariff of Nicaragua (Tariff Series No. 40), prepared by the collector general of customs of Nicaragua. Because of the comparatively few changes in tariff legislation during the war, the falling off in the publication work of the division did not interfere to any serious extent with the services rendered to American business men. It is hoped that the early abolition of the war restrictions will make it possible to devote more attention to the new tariff measures now being prepared in a number of European countries.

### MISCELLANEOUS WORK.

The material collected in the course of the preparation of the report on reconstruction ("Economic Reconstruction," Miscellaneous Series No. 73) has been classified and expanded, and the division has followed certain phases of economic reconstruction in the principal belligerent countries. As a result of the establishment of the liaison system by the Department of State, the division has kept in closer touch with the work of that Department and has gained greater access to the tariff material received there. The question of the expansion of American parcel-post facilities with foreign countries has figured rather prominently in the correspondence, and the division has kept in close touch with the activities along those lines carried on by the Post Office Department. It is gratifying to note that the economic importance of parcel post is receiving more recognition and that parcel-post service to a considerable number of countries has been inaugurated during the past year.

## RESEARCH DIVISION.

The work of the research division has consisted, as heretofore, in preparing special economic and statistical material in order to give an adequate background to inquiries that could not be answered sufficiently by the data appearing in Commerce Reports and other publications of the Bureau; in compiling the Statistical Abstract of the United States, the annual pamphlet on wholesale prices, and other publications dealing with the statistics of foreign countries; and in reading foreign journals with special reference to the economic and trade conditions and the resumption of normal industry in European countries.

## PUBLICATIONS ISSUED.

Six publications have been prepared in this division during the year—the Statistical Abstract of the United States, the annual pamphlet on wholesale prices, Statistics of German Trade, Statistics of Austro-Hungarian Trade, International Trade in Footwear Other than Rubber, and International Trade in Cement. In addition, there were prepared in this division the statistical tables for the Bureau's pamphlet on Economic Reconstruction in European Countries.

## STATISTICAL ABSTRACT.

The Statistical Abstract of the United States has been along much the same line as in previous years, with the exception that there have been added tables showing the war activities of the Government, these tables having been compiled from the published reports of the War Department, the Navy Department, the American Red Cross, and other war organizations, or taken from special statements submitted for the purpose by these bodies. The Statistical Abstract, which was issued for the forty-first time during the year just past, contains in compact form a summary of all important statistical information published by the various departments of the Government. For the investigator who is interested only in general figures, the Abstract furnishes sufficient data without requiring him to consult the many voluminous books on which it is based. For the student who is not acquainted with the sources of information and who desires more detailed figures, the Abstract is the best guide to the volumes that contain the statistics in detail.

## WHOLESALE PRICES.

The pamphlet on wholesale prices has followed the same line as in previous years, and gives the prices of a number of selected commodities in the principal markets of the United States. This pamphlet has been issued for several years, and the various issues, together with the similar tables previously published in the Monthly Summary of the Foreign Commerce of the United States, give a comprehensive view of the price movement in the raw materials for, and the products of, the basic industries of the country.

## GERMAN AND AUSTRIAN TRADE STATISTICS.

The trade and economic status of the central powers have received considerable attention, both in their historical aspect and in their recent developments as indicated by the journals that have been received from Germany, Austria-Hungary, and other European countries. The import and export trade of Germany and Austria-Hungary is presented statistically in Miscellaneous Series Nos. 75 and 77, respectively. Miscellaneous Series No. 75, Statistics of German Trade, is a reprint of the statistical material contained in two earlier publications of the Bureau—Miscellaneous Series No. 57, German Foreign Trade Organization, and Miscellaneous Series No. 65, German Trade and the War. In it are shown the imports and exports of Germany by countries and principal commodities for the five years preceding the war. Values only are given, and the items shown in the German statistical reports are grouped in related classes of commodities unless a particular commodity forms an appreciable part of the trade, in which case it is shown separately. Some general statistics showing the internal development of Germany are also included.

Miscellaneous Series No. 77, Statistics of Austro-Hungarian Trade, is along the same lines as the pamphlet on German trade, but there have been included some pages of text discussing the principal items that enter into the trade. There have also been included such statistics as are available regarding the trade and industries of Bohemia and of the portions of the former Austrian Empire that are included in the new state of Jugoslavia.

These two reports have proved of great value to all students of the economic development of the central powers as well as to business men who are interested in the markets formerly supplied by Germany and Austria-Hungary. While the statistics are in many cases somewhat condensed, the original reports are on file in the Bureau, and the detailed statistics are available to those who desire to consult them. These two publications indicate the general line along which the Germans and Austrians developed their trade and serve as a valuable guide to the merchant who desires to know what class of goods these competitors sold in foreign countries before the war.

It is unfortunate that it is not possible to give statistics of the trade of the Provinces that have been taken from the central powers and formed into new States. The Bureau has received many requests for information of this character, but these statistics do not exist, as the trade of these sections of Germany and Austria can not be differentiated from the trade of the countries as a whole.

### RAW-MATERIAL SITUATION BEFORE THE WAR.

The statistical tables in Miscellaneous Series No. 73, Economic Reconstruction, show the situation in 1913 as regards foodstuffs and the principal industrial raw materials in the United States, the United Kingdom, France, Russia, Italy, Germany, and Austria-Hungary. These tables show the production, the imports and the principal countries from which they were obtained, the exports and the principal countries to which they were consigned, and the apparent consumption, as computed from the statistics of production, imports, and exports. They have been of great value to all persons interested in the economic development of the United States and the principal belligerent nations in Europe, as they bring together more compactly than has ever been done before the data that show the dependence or independence of the countries discussed as regards their principal food supplies and industrial raw materials.

### INTERNATIONAL TRADE IN FOOTWEAR.

Two important American industries, the shoe and the cement, are represented in two publications containing foreign statistics issued during the year. Miscellaneous Series No. 76, International Trade in Footwear other than Rubber, contains statistics of imports for all countries whose foreign purchases exceeded $300,000 in either of the years considered and statistics of exports for the same years for countries whose foreign sales exceeded $3,000,000 in value.

### INTERNATIONAL TRADE IN CEMENT.

The report on cement gives import and export statistics for foreign countries for 1908, 1913, and the latest years for which detailed statistics have been received. Import statistics are given for all countries whose purchases exceeded $200,000, and export statistics were compiled for all countries whose sales exceeded $1,000,000 in any of the years mentioned.

### STATISTICAL STUDIES IN PREPARATION.

Other studies of this character (in various stages of preparation) include Cotton Goods, which is almost ready for the printer; Motor Vehicles and Bicycles, which will go to the printer early in the fiscal year; Horse-Drawn Vehicles; Agricultural Implements and Machinery; Paper and Manufactures of Paper; Electrical Goods and Machinery; and Manufactures of Leather other than Boots and Shoes. All of these studies give statistics for 1908, 1913, and the latest available year, with the exception of the report on the cotton-goods trade of the world, which gives figures for the five years 1909 to 1913.

### GENERAL STATISTICAL DATA.

As in previous years, the research division has supplied statistical data of all kinds relating to foreign countries. Because of the small force in the division, it has not always been possible to supply all the data requested, as the time required for the compilation of information could not be spared from the regular statistical studies in hand. With the increase in the photostat facilities available in the Bureau it is hoped to be able to comply with practically all requests of this character. Photostat copies of the pages in the statistical reports will be made at cost in order to make available to exporters a mass of material in foreign reports that heretofore could not be furnished because of the lack of a sufficient clerical force to transcribe the figures.

### FOREIGN INVESTMENTS.

In order to assist in placing American trade with foreign countries on the firmest possible basis, one of the experts of the division, during the last half of the fiscal year, paid special attention to the possibilities for investing American capital in foreign countries. A great part of the success of some of our European competitors has been due to the large investments that have been made in public utilities and industrial enterprises. Prior to 1913 the American investing public thought little of investing capital in foreign countries. Our own industries and utilities not only absorbed all our floating capital, but we looked to European countries for additional supplies to finance our large industrial undertakings. That condition no longer exists. We have absorbed practically all the loans that were placed in Europe before the war, and should have sufficient capital available to make considerable advances to other countries. In the Far East and South America are great resources that have hardly been touched, and in these countries are great numbers of inhabitants whose purchasing power as regards the goods we offer is practically nil. By development of the industries of these countries the consuming capacity of the population may be enormously increased and new markets created in which we should have no difficulty in obtaining a fair share of the trade.

It is the purpose of the Bureau to keep in close touch with all opportunities for the investment of capital and to bring them to the attention of American investment houses. The mass of material that is available in the Bureau on the economic development of foreign countries will enable us in most cases to furnish the necessary facts to serve as a background for the broader aspects of an investment opportunity in the line either of public utilities or of specialized industries.

## DIVISION OF STATISTICS.

### WAR ACTIVITIES.

During the first half of the fiscal year the efforts of the division of statistics, aside from the regular work of preparing the statistical publications, were directed mainly toward furnishing the special war bureaus with the detailed foreign-trade statistics required by them. The different divisions of the U. S. Shipping Board made probably more extensive use of the statistics than any of the other war offices. As a basis for the control and allocation of ships for imports of essential war materials for which the United States depended upon foreign sources, the division of planning and statistics was supplied regularly with reports of imports during 10-day periods covering from the 1st to the 10th, the 11th to the 20th, and the 21st to the last day of each month. These reports, beginning with July, 1918, show imports of each class according to the long or quarterly classification by countries from which shipped and customs districts where entered and give a complete picture of the import trade.

The port and harbor facilities commission of the Shipping Board made extensive use of the monthly reports showing imports and exports of each customs district by articles and countries. The commission undertook to lay out a plan for routing the import and export trade along the most economical railway and steamship paths, and it continually required statistics. Many inquiries were received from this commission, as well as from chambers of commerce and boards of trade, for statistics relating to coastwise vessel movements and domestic and coastwise trade. Since 1912, when our former service of "Internal Commerce" was discontinued, the only information available along these lines has been contained in the annual report of the Chief of Engineers, U. S. Army, published by the War Department. This consists of three large volumes containing the individual reports submitted by the district engineers stationed at the various sea and river ports, and contains such more or less incomplete statistics as they have been able to gather for their respective localities. To construct statistical tables from these scattered reports is a well-nigh hopeless task, and our labors in this direction have emphasized the importance of continuing efforts to obtain an appropriation from Congress for the systematic collection of internal-commerce statistics.

The division of operations of the Shipping Board made extensive use of our reports of " Vessels Entered and Cleared in the Foreign Trade," and the division of trade received our aid in constructing tables showing commerce in leading staple articles, by ports and countries, previous to and since the war.

The Food Administration and the Bureau of Markets of the Department of Agriculture have been furnished with 10-day reports of imports and exports of foodstuffs and agricultural raw products. The various divisions of the War Industries Board and the Council of National Defense made constant inquiries for foreign-trade statistics in connection with their work of priority rulings, price fixing, and other war restrictions, and were listed for numerous special monthly and 10-day statements. The Geological Survey, the Bureau of Mines, and the interdepartmental War Minerals Committee kept in close touch with imports and exports of nonferrous metals, coal, mineral oil, nitrogenous materials, and other essential minerals, and were kept regularly supplied with the latest statistics.

The War Trade Board made continual use of the import and export statistics; its bureau of research was regularly furnished with copies of the 10-day and monthly export reports; and every facility was given to enable the board to keep statistical records up to date. Numerous special tables were also furnished to the import and export bureaus, trade advisers, and other offices of the War Trade Board. Regulations were prepared in conjunction with the Treasury Department by which a copy of every import entry and export declaration was required to be forwarded by collectors of customs to the bureau of tabulation and statistics for the purpose of compiling therefrom actual imports and exports as a check against the licenses issued by the War Trade Board. The bureau of research and other divisions continued, however, to rely on the statistics issued by the Department of Commerce.

The central bureau of planning and statistics, organized by Dean Edwin F. Gay, was supplied with information concerning significant developments in foreign trade during the war, for the use of the War Industries and other war boards and, after the armistice, for the information of the President and the Interallied Peace Commission. They were furnished with monthly and yearly statistics of imports and exports by countries and leading commodities, such figures being used by them in constructing graphic charts showing current changes in the foreign trade.

The Committee on Public Information, the Alien Property Custodian, the Director General of Railroads, and other war and regular government establishments made frequent calls on the division for statistics, which in many cases required extensive research and compilation. As the statistical work increased additional clerks were employed out of the special fund allotted by the President from the appropriation for "national security and defense." Even with this increased force it was not possible to undertake all of the special compilations required for the various problems of the war boards, and in many cases this work was performed by clerks detailed by them to the division, who were given access to the statistical records. The Shipping and War Trade Boards each had, on an average, about 10 clerks constantly working on statistics in this Bureau, with occasional details from the Food Administration, the Bureau of Markets, and other offices.

Since the signing of the armistice this extensive use of our foreign-trade statistics by the war boards has gradually diminished. The Food Administration was the first to dispense with the 10-day import and export reports of foodstuffs, and, after the consolidation of its statistical division with the Food Administration Grain Corporation at New York, it was furnished only with advance monthly figures. The Shipping Board dispensed with the 10-day reports after February, but continues up to the present to make extensive use of the monthly statistics. The War Trade and Shipping Boards both continued to detail a few clerks for special compilations from the Bureau's records up to the close of the fiscal year. The Bureau of Markets discontinued the use of the 10-day reports after June. These reports were started as a temporary measure for the confidential use of the war boards and have been discontinued. The division has had a number of calls for weekly statistics of imports and exports for special industries, among others for lumber, hides, and leather, but neither the customs service nor the Bureau has means for handling more than monthly reports.

### SPECIAL STATISTICAL SERVICE.

Through the work of the war boards in control of imports, exports, domestic industries, and shipping space, the commercial public has been widely educated to the use of foreign-trade statistics. This is shown in the increased calls upon the Bureau for statistics of imports, exports, production, and consumption in every line of industry. It is evident from these inquiries that statistics are regarded by business men as not merely of academic interest, but as of practical value in problems involving the establishment of domestic industries or the extension of foreign markets for their products. Since the armistice, as the statistical work for the war boards has diminished, it has been the policy of the division to give special attention to correspondents and to furnish as complete statistics as possible bearing upon the inquiries submitted.

It has been apparent for years that the statistics published in the Monthly Summary, showing only total quantities and values of all commodities and principal countries for the most important articles, do not answer the needs of business men who use the statistics. For too many items in the Summary the figures under "All other countries" are growing larger and larger as trade currents change, especially since war times, and it has not been possible to bring out separately many countries that have recently become important. It has also been stated many times that the very fact that commerce with certain countries is small is of particular interest to the trade and that business men should be kept informed of this.

To answer this demand, the division has for several years maintained a limited service of furnishing special monthly statements to certain parties showing more detail than the published reports, but from time to time the propriety of furnishing this service to a limited number of persons has been questioned. In response to the constantly increasing demand for more detailed statistics during the latter part of the war, when commercial concerns were formulating plans for extending their export trade as soon as war restrictions should be removed, it was decided to extend this service by furnishing it to such trade journals and commercial organizations as would agree to give publicity to the statements. An announcement to this effect was published in the daily Commerce Reports and in the press, inviting suggestions, in response to which the demand for this service has exceeded all expectations.

This work was started with statistics for December, 1918. After it had been in operation for six months, 1,178 copies of 81 statements of imports and exports of specified commodities during May, 1919, were furnished to about 300 different addresses, mostly those of commercial organizations and trade journals. The statements range from letter size for single classes to tables of more than 20 columns for groups such as electrical machinery and india-rubber manufactures. The originals are typewritten, and additional copies are made by the photostatic process. The division requires individual acknowledgments for these statements, and has received many expressions of appreciation.

Special arrangements have been made with Washington correspondents of trade journals by which they are given access to the copy for the Monthly Summary, before it is sent to print, for the purpose of copying the current figures for the particular lines in which they are interested. In this way the figures of imports and exports for the principal lines of industries—including, among others, automobiles, textiles, iron and steel, and hides and leather—appear in the trade journals a week or more in advance of the official statistical publications.

### STATISTICAL PUBLICATIONS.

The issues of the Monthly Summary were much delayed during the war, partly because of delay in the receipt of the monthly reports from the Bureau of Customs Statistics, caused by the additional 10-day reports and other special statistical compilations for the Treasury and other Government departments. There was also much delay at the Printing Office, caused by the great volume of printing to be handled for the special war offices, draft boards, and other war organizations, which was given precedence over the regular departmental printing.

The Bureau of Foreign and Domestic Commerce is aware of the importance of promptness in the statistical service and is giving much attention to the coordination of this work with the Customs Service of the Treasury Department, through which the reports are collected. In recent months, as the pressure of special war work has diminished, there has been a notable improvement in this regard. The Bureau of Customs Statistics of the Treasury Department is furnishing the reports by the 20th of each month, copy is sent to print around the 25th, and printing is usually finished by the 10th of the next month. An attempt will be made to arrive at an agreement with the Government Printing Office for expediting the printing of the statistical publications by arranging a regular schedule for furnishing copy, sending proof, and completing the job on a specified date each month.

Through the special efforts of the Division of Publications of the Department of Commerce, backed by the Shipping, War Trade, and War Industries Boards, urging upon the Public Printer the necessity of expediting the printing of the Annual Report on the Foreign Commerce and Navigation of the United States for the fiscal year ended June 30, 1918, this publication was delivered on April 5, 1919, which, compared with former years, was an unusually early date.

The act of Congress, approved January 25, 1919, amended section 336 of the Revised Statutes, by requiring that the Annual Report shall be issued to cover the calendar instead of the fiscal year. This change had been advocated by the Treasury and Commerce Departments, the Chamber of Commerce of the United States, and other organizations, for the reason that the business year in general use by commercial concerns in this country is the calendar year. Many United States Government bureaus and most foreign countries issue their statistical reports for the calendar year, and the change in our foreign-trade statistics to this basis will facilitate comparisons.

In view of the great demand from industrial and commercial organizations and firms for up-to-date foreign-trade statistics, the Bureau undertook to prepare, in addition to the fiscal-year report, an Annual Report on the Foreign Commerce and Navigation of the United States for the calendar year 1918. In order to provide a continuous record for the intervening period between the fiscal and calendar years, the figures for the half year from July 1 to December 31, 1918, are shown in all of the tables in addition to the calendar-year figures. All of the tables were completed and in the hands of the printer by the end of May.

The usual publication, Trade of the United States with the World, showing imports and exports in the trade with each foreign country by articles, was brought up to date for 1918 and issued as Miscellaneous Series No. 78. A special compilation was made and published in Commerce Reports of the imports into and domestic exports from the United States during the calendar year 1917, stated in the terminology of the international classification agreed upon at the International Statistical Congress at Brussels in 1913. This was undertaken at the request of the International High Commission, of which the Secretary of the Treasury is ex officio the chairman. A reprint of the statement was furnished to that commission to be translated into Spanish for distribution to the Governments of the Central and South American countries as a step toward uniformity in the classification of foreign-trade statistics in American countries.

Steps are being taken to change the tables in the foreign-commerce section of the Statistical Abstract from fiscal to calendar years.

### REVISION OF STATISTICAL CLASSIFICATION.

The demand for statistics on the part of the war boards emphasized the lack of detail in the classification of foreign-trade statistics, especially regarding exports from the United States. In response to this demand a revision and extension of the export classification was undertaken in the latter part of the fiscal year 1918 with the cooperation of the Bureau of Research of the War Trade Board, the Food Administration, and the trade experts of the Shipping and other war boards. As this work progressed it became evident that more was needed than a mere extension or subdivision of the present export classification, and that a thorough revision of both imports and exports was necessary in order to obtain closer comparability in foreign-trade movements. This matter was brought to the attention of the Secretary of Commerce, and an interdepartmental committee was appointed, consisting of representatives of the Treasury, Commerce, and Agriculture Departments, the Shipping and War Trade Boards, and the Tariff Commission, for the purpose of preparing, from the ground up, an entirely new classification applicable to both imports and exports.

After thorough consideration it was decided that the present alphabetical arrangement should be discarded and that the commodities in the new classification should be grouped in 10 great classes according to their character, the nature of the component material rather than the use of the article being the guiding principle in classifying. Each of the 10 main groups is to be divided and subdivided into subsidiary groupings, the decimal system of numbering being used in order to facilitate mechanical tabulation and to provide elasticity for future expansion. Comparability between imports and exports is to be preserved, but in cases where the imports or exports are not of the same importance for certain groups the classification will not be shown in the same detail. Quantities are to be shown wherever practicable, either in standard commercial units or in weight.

G. B. Roorbach, special expert in the division of planning and statistics of the Shipping board, was designated as chairman of the committee and placed in charge of the actual construction of the classification. An announcement was published in the daily Commerce Reports and was furnished to the press, inviting suggestions from the trade, and the response has been generous. Mr. Roorbach has had the active cooperation of trade organizations and experts who have prepared detailed schedules for their particular lines, and an immense amount of material has been accumulated. Naturally each trade was anxious to obtain detailed statistics and prepared elaborate classifications for its particular line of industry. This was especially the case in the chemical, electrical, machinery, hardware, and other highly diversified lines of trade. The arrangement and condensation of the various classifications submitted, into an orderly plan commensurate with the means for statistical work at the disposal of the Department, has proved to be a huge task.

The schedule, while not finally completed, was presented, with a general outline of the results of the work of the committee, to the Secretary of Commerce, who approved the new classification in principle and in substance. The Secretary of the Treasury has likewise given his approval. At the present time the schedule is undergoing detailed examination in the Bureau and by Treasury experts in the New York Customhouse, for statistical and tariff requirements.

To tabulate the returns under the new classification will require a material increase in personnel and equipment at New York. The Bureau is preparing the way for the transition by simplifying and renumbering the schedule, by choosing the most suitable units of quantity, and by compiling a comprehensive glossary. The task of final revision has been put in the hands of the chief of the division, in consultation with the acting statistical adviser, Frank R. Rutter, formerly commercial attaché at Tokyo.

### MISCELLANEOUS PROBLEMS AND ACTIVITIES.

On account of the crowded condition of the quarters of the Bureau in the Commerce headquarters building, the statistical division and all of the statistical record books were moved in January to the Council of National Defense Building. This separation from the other divisions of the Bureau has proved very inconvenient—for the division and the Bureau in conducting their work, as well as for the public—and it is hoped that it may be possible soon to bring the divisions together again in one building.

The Bureau of Customs Statistics at New York, as well as the division of customs of the Treasury Department and the Customs Service as a whole, has worked hand in hand with the Bureau in supplying the war boards with needed statistical information. Many special investigations were made requiring overtime work, and acknowledgments are due the officials and employees of these branches of the public service for their untiring efforts. The compilation of the 10-day import and export and many special reports, in addition to the regular monthly statements, was successfully handled by means of the mechanical tabulating machines in the Bureau of Customs Statistics.

On account of the changes made in the import classification, some difficulties were encountered in the compilation of the imported merchandise remaining in bonded warehouses, making it necessary to take a correct inventory of stocks in warehouses at each customs port of entry. This had previously been considered an impossible undertaking, but through the ingenuity of J. F. Carroll, chief of the Bureau of Customs Statistics at New York, and formerly in charge of the warehouse division at that port, it was successfully carried through, and many errors in the statistical warehouse accounts that had been carried forward from month to month were eliminated.

Aid was furnished to the price section of the War Trade Board in compiling an international comparison of wholesale prices during the war. This work was begun by the War Industries Board, and after the dissolution of that office was taken over by the War Trade Board and published by the Department of Commerce. It has been suggested that this work should be continued by some branch of the permanent Government service, and after consideration by interdepartmental committees it seems assured that at least part of it will be continued, probably by the Federal Reserve Board in connection with its investigations of foreign exchange.

After the armistice the division was able to obtain a number of clerks experienced in statistical work whose services were dispensed with by the War Trade Board. They were employed on the temporary roll of "national security and defense" and rendered excellent service. It was largely because of this extra help that the division was able to compile the tables for the Annual Report on Commerce and Navigation for the calendar year 1918. Unfortunately, it was not possible to keep these employees in the service of the Bureau after the expiration of the fiscal year. We were able to offer them only the salaries of vacant statutory positions at $900 and $1,000 per annum, which they refused to accept in view of the higher salaries offered by other branches of the public service operating on lump-sum appropriations.

## DIVISION OF TRADE INFORMATION.

The division of trade information supplies, through correspondence and personal interviews, data on foreign markets for American goods in all parts of the world not covered by other divisions of the Bureau organized to deal with specific geographical sections—that is, Latin America, the Far East, and Russia.

### TRADE-PROMOTION WORK.

War-time restrictions on the movement of normal trade shipments (though they were in full force during only a part of the year) and the shortage of shipping space for goods other than war material and foodstuffs naturally affected to some degree the interest of American manufacturers and exporters in trade other than strictly war business. This was markedly noticeable, however, only during the early months of the year. Immediately upon the signing of the armistice the number of trade inquiries began to increase, and the facilities of the division have been taxed to meet the truly phenomenal demand for trade information.

The organization of a Russian division in the Bureau, to which all inquiries concerning Russia are referred, and the natural lack of interest in regular export trade on the part of the business public during the four months preceding the signing of the armistice tended to decrease somewhat the total number of trade inquiries received; nevertheless, approximately 45,000 outgoing communications were prepared during the year.

The remarkable expansion of certain lines of domestic industry, as a direct result of the war, is, of course, a matter of general knowledge. Upon the cessation of hostilities, American manufacturers whose business had grown from small establishments to large-scale plants, as a result of war orders, began quite naturally to cast about for some means to keep their plants and organizations intact and thus avoid the unpleasant task of reducing their forces and curtailing production. A fact clearly emphasized by the oral and written inquiries received by the trade-information division is the remarkably large proportion of these houses that have turned to foreign trade as a solution of their problems.

As was to be expected, the trade inquiries coming in during the months immediately following the armistice indicated a decided preference for French and Belgian markets, but as a better understanding of conditions in these markets was acquired there was a tendency to give attention to other important fields as well, and many inquiries on Scandinavia, Spain, Portugal, South Africa, and the Near East are now being handled.

The division has been called upon during the year to furnish specific data regarding definite foreign markets for practically all lines of American manufactures and raw materials of a character suitable and available for export. This matter of general adaptability for export shipment is not, however, in all cases a feature of the inquiries received and is often developed, at least from the correspondent's point of view, after the dispatch of one or more letters of diplomatic and disinterested advice. There are numerous time-worn examples that might be cited in this connection, but occasion will be taken to refer to only one recent instance—that of an American house which wanted, very earnestly and very persistently, to sell hay in a European country during the very height of the shipping emergency.

### EQUIPMENT AND FILES.

The division's facilities for taking care of trade inquiries have been greatly strengthened by the transfer to it of files of certain unpublished material, comprised mostly of copies of reports and letters prepared by American consular officers and the Bureau's own foreign representatives in answer to specific inquiries made directly by American firms and individuals. This manuscript material is used currently and systematically to supplement the published reports of the Bureau, and it is proving of very practical service. These reports come in every day, and with a view to utilizing them, not only for the current inquiries, but also in order that correspondents who have previously expressed an interest in some phase of foreign trade may have the benefit of pertinent reports received after their inquiries were answered, a follow-up system has been devised and put into practical operation.

While this division is occupied primarily in answering what may be termed "foreign-trade" inquiries, special facilities for taking care of other classes of requests, related more or less directly to some phase of foreign or domestic trade, have been built up and are gradually being developed. For example, in this class may be mentioned a file of more than 100 trade directories covering practically all industries for the United States and other principal countries, a special card index of American importers arranged by articles imported, a classified card index of American firms that carry advertisements in export-trade periodicals, etc.

It has been possible during the year to give more direct and specialized attention to this important feature of our trade-promotion work. As an example of the practical working of this service, the division has furnished to a number of the American commercial attachés stationed in Europe and Latin America specially compiled lists of American importers of raw materials produced in their respective localities and forming important lines of import into the United States.

The division frequently receives requests for the names of manufacturers of specified articles, and it is also called upon from time to time to give individual distribution to special inquiries indicating some unusual opportunity in a foreign country for the sale of some particular class of American merchandise. Special facilities and a wide general knowledge of sources of information regarding American firms engaged in different lines of industry have enabled this division to be of definite service in many cases of this kind.

An important addition to the files of the Bureau was the acquisition in May of certain records of the War Trade Board covering foreign firms and individuals who are possible purchasers of American goods. The maintenance of these records and the distribution of the information which they contain to interested American firms and individuals was placed under the supervision of the trade-information division.

### RESULTS FROM CORRESPONDENCE.

The number and class of the commendatory letters received indicate that the division's work is appreciated and that it renders practical and efficient service to its correspondents. The following are quoted as typical of the class of acknowledgment received:

From one of the largest manufacturers of chains in the United States:

> We thank you very much indeed for your kind letter of November 18. together with inclosures, which have our careful attention. We appreciate very greatly the detailed information which you have furnished us and which is of great value.

From a Cincinnati manufacturer:

> It is very good of you to detail so carefully and minutely to us the contents as presented in your letter dated December 5. Careful perusal has been made thereof, and the information furnished will be of great help to us.

From one of the largest and most progressive manufacturers in the country:

> We highly appreciate the complete manner in which you have handled our inquiry of May 31.

From one of the large motion-picture producers:

> We are more than pleased with the service rendered us by the Bureau of Foreign and Domestic Commerce.

From an important national bank in New York:

> Kindly accept our thanks for the reports mailed us on April 18 in response to our request of April 11. We find these are of great value to us.

From one of the large American dyestuff manufacturers:

> We desire to thank you for your very complete letter of October 8 and information inclosed therein. We shall be able to derive much benefit from these reports. We appreciate the many courtesies extended.

### COOPERATION WITH COMMERCIAL ORGANIZATIONS.

In connection with its trade-promotion work, the Bureau maintains close cooperative arrangements with the principal commercial organizations throughout this country. The supplemental publicity given to the Bureau's publications and special services through cooperation with those representative trade organizations that have regularly established foreign-trade bureaus is important, and it has been our policy to encourage these relations whenever opportunity offered. In turn, the trade-information division is frequently able to be of definite assistance to these associations and their individual members. It is also often called upon by newly established associations, having in mind the organization of foreign-trade departments, for advice and constructive suggestions that will assist them in organizing, developing, and carrying on a special service of this kind.

The following commendatory letters received from commercial organizations indicate that our service is appreciated:

> "Rarely has anything come into this office that gave me more pleasure than the arrival of the collection of data which accompanied yours of September 12. This is of interest not only to my association, but to several technical societies."
>
> "Permit me to thank you for your letter of March 4. We assure you that your cooperation is proving of great assistance to us."
>
> "Please accept my sincerest thanks for your kindness in securing the release of the list of producers of sulphuric, nitric, and hydrochloric acids requested in our telegram of January 6. I know that the member for whom we requested this information will also greatly appreciate your genuine service."
>
> "We wish to thank you for your recent letter with various inclosures on the subject of foreign trade and exports and would say that this information is very much appreciated. It is a guiding hand in the formation of our foreign-trade bureau, and no doubt will prove of great value in our service to local industry."

In cooperation with the Department of State and the Chamber of Commerce of the United States, plans were developed and carried out with a view to assisting the management of the Fourth Lyon Sample Fair to get in touch with American manufacturers who might be interested in arranging for exhibits at the Fair. The official representatives of this Fair in the United States complimented the Bureau very strongly upon the assistance that it rendered in this respect.

### WAR WORK.

The trade-information division's direct participation in what may be termed strictly "war work" was limited. It was called upon, however, to furnish information and suggestions as to sources of names of American firms, and it had occasion also to be of assistance to the War Department in arranging for that Department to take advantage of the Bureau's service in its work of disposing of surplus supplies and property.

Another feature of our service that can probably be appropriately referred to under this head is the assistance rendered to American firms and individuals who desired to locate domestic sources of merchandise formerly imported from one of the central powers. Our special facilities for keeping in touch with new industries, coupled with a wide and varied knowledge of unofficial sources of such facts, has enabled the division to be of assistance in many cases of this kind. The division has frequently been able to divert transactions from foreign to American houses, apparently to the entire satisfaction of the buyer.

### COMMERCIAL INTELLIGENCE SERVICE.

Plans are under way for the expansion of the Bureau's commercial intelligence section, which was created for the purpose of providing American firms with reliable information in regard to prospective buyers or agents all over the world. Because of the obvious importance of this work, it is hoped that it may be possible to prosecute it diligently. The officials of the Bureau are convinced that the establishment of the contemplated service will be of incalculable value to American industry, closing a serious gap in our present trade-promotion work.

The work of this character hitherto done by the Bureau has consisted in the furnishing of trade lists for various lines of business, without any information as to the relative importance of the firms shown or the character of the business conducted by them—that is, whether wholesale, retail, general importing, commission transactions, or business of other types.

Investigation has proved that certain of the Bureau's lists have become obsolete, and at times the names of very small and almost insignificant importers have been found in these trade lists, because we have had no means of checking them or of ascertaining the comparative position of the firms.

In quoting prices to a new foreign firm, it is often very essential that the American manufacturer be informed concerning the character of the business of the foreign firm, in order to avoid the possibility of quoting wholesale prices to a retailer. In connection with contemplated agency arrangements, it is highly desirable for the American firm to possess at least a general idea of the relative standing in the community of the prospective agent under consideration, so that a profitable market may not be tied up for a series of years in the hands of an inexperienced (or possibly an unreliable) representative.

If the proposed service is put into effect, additional and vital details will be available, such as the estimated capital of the foreign house, the character of its business organization (corporation, partnership, or other form), the manner in which payments are usually made, whether it maintains local traveling representatives and branch houses (and if so, where), the language in which correspondence is preferred, whether purchases are ordinarily domestic or foreign, the firm's general standing in the trade, and other information that is certain to prove peculiarly useful to the exporters in this country.

In collecting the requisite data, it is planned to utilize principally the American consular service, supplemented by certain assistance from our commercial attachés and trade commissioners. The work of recording, classifying, and distributing the data is to be accomplished in this Bureau. As soon as the basic material is received from the consuls, the Bureau plans to prepare an elaborate card catalogue directory, with the cards filed by commodities—a directory which, it is hoped, will represent the more desirable prospective buyers of nearly every line of merchandise in all parts of the world. This information will then be further refined in the form of mimeographed commodity trade lists which can be furnished to cover a given section of one country, an entire country, a group of countries, or the entire world. The comparative size of firms will be indicated by one, two, or three stars.

The service is now in operation in a very limited manner, with one clerk endeavoring to look after the work. Though it has been given practically no publicity, many requests are being received for specific information of the character outlined. The demand is being clearly manifested, and there is unquestionably a very genuine need of obtaining and conveniently classifying just this kind of information for the intelligent, careful promotion of American export business. It will obviate many difficulties and losses. It will solve perplexities and prevent waste of energy. Service of this kind will be a guide to merchants planning trips; will save useless calls of traveling salesmen; will be of signal service in making discounts; will enable the Bureau to act judiciously in publishing trade opportunities and adjusting complaints; and will, in general, replace uncertainty with accurate knowledge.

## EDITORIAL DIVISION.

The effect of the armistice upon the work of the Bureau is well illustrated by the increased output of the editorial division. Up to the time hostilities ceased there was so pronounced a shortage in incoming reports from the consuls and the Bureau's own field staff that for a time the division seemed confronted with the inevitable necessity of reducing the size of Commerce Reports. But within a month after the armistice was signed there were so many reports in hand that the facilities of the division and of the entire Bureau were taxed to give them proper distribution.

The work performed in the divison during the fiscal year 1919 amounted to approximately 12,800 printed pages, as compared with 10,872 pages during the preceding year. Fourteen monographs were prepared for publication in the Special Agents Series and 12 in the Miscellaneous Series. The number of pages in Commerce Reports jumped from 4,912 in 1918 to 5,760 in 1919, the increase occurring during the last six months. The number of Foreign Trade Opportunities published in this daily paper increased from 806 for the first six months of the fiscal year 1919 to 1,897 for the six months just closing. An increase of more than a thousand in the paid circulation of the paper has also taken place.

A new series of publications, designated Industrial Standards, which will give substantial aid in trade promotion with Latin America, made excellent progress during the year. The first 62 numbers in the series have been issued. They are bilingual editions, in Spanish and English, of standard specifications of the American Society for Testing Materials. The specifications selected for translation and publication by the Bureau relate to various industrial materials, such as Portland cement, railway construction materials and equipment, structural steel, pig iron, copper, linseed oil, turpentine, etc. Copies distributed in Spanish-speaking countries have been favorably received by Government bureaus, engineering societies, and individuals. This work will be continued during the current year by the translation of these specifications into French and the publication of French-English editions for distribution in the several countries of Europe where that language is used. It is also planned to publish a bilingual edition, in French and English, of the Standardization Rules of the American Institute of Electrical Engineers.

One of the important books prepared for publication during the past year has been the Commercial Handbook of China, which will be issued in two volumes, of approximately 700 and 400 pages, respectively, and will be appropriately illustrated.

A report was issued on chemicals and allied products imported into the United States during the last year of normal trade, to which is appended a survey of the domestic manufacture of these products, based on the census of manufactures for 1914. A valuable feature of the report is a very complete table that lists by their commercial names all chemical and allied products imported in excess of $100 in value and shows for each the quantity and value imported and the percentage of quantity from each foreign country. This table contains the names of 2,500 products, classified alphabetically by groups, and a list of 3,000 other products imported in amounts less than $100 each is added.

Two volumes of an educational character were prepared, being the joint product of the Federal Board for Vocational Education and the Bureau of Foreign and Domestic Commerce. The first is entitled "Selling in Foreign Markets" and consists of selected readings from published statements of business men and reports of experts on methods employed in export trade. The second is called "Paper Work in Export Trade" and is devoted to a consideration of document technique. The Bureau has long recognized the need for more thorough instruction in exporting methods, principles, and routine.

The following table summarizes the publications of the Bureau during the year, all of which, excepting those on foreign tariffs and the purely statistical publications, were handled by the editorial division.

PUBLICATIONS ISSUED DURING THE FISCAL YEARS ENDED JUNE 30, 1917, 1918, AND 1919.

| Publications. | 1917 | | 1918 | | 1919 | |
|---|---|---|---|---|---|---|
| | Number. | Pages. | Number. | Pages. | Number. | Pages. |
| Commerce Reports | 306 | 4,896 | 305 | 4,912 | 306 | 5,760 |
| Supplements to Commerce Reports | 107 | 1,735 | 110 | 1,608 | 98 | 1,135 |
| Index to Commerce Reports and Supplements | 5 | 217 | 5 | 218 | 5 | 169 |
| Special Consular Series | 1 | 12 | 5 | 264 | ........ | ........ |
| Special Agents Series | 27 | 2,344 | 26 | 2,609 | 14 | 1,966 |
| Miscellaneous Series | 24 | 2,752 | 11 | 1,112 | 12 | 2,477 |
| Industrial Standards | ........ | ........ | 1 | 27 | 61 | 1,057 |
| Monthly Summary of Foreign Commerce | 12 | 1,104 | 12 | 1,164 | 12 | 1,200 |
| Commerce and Navigation | 1 | 950 | 1 | 956 | 1 | 1,031 |
| Statistical Abstract | 1 | 773 | 1 | 804 | 1 | 881 |
| Other statistical publications | 29 | 412 | 25 | 402 | 16 | 330 |
| Tariff Series | 3 | 66 | 3 | 159 | 2 | 118 |
| Foreign Tariff Notes | 4 | 192 | 3 | 192 | 2 | 154 |
| Confidential Bulletins | 1 | 42 | 1 | 73 | 2 | 86 |
| Annual Report of Chief of Bureau | 1 | 97 | 1 | 77 | 1 | 93 |
| Catalogue of Bureau's Publications | [a] 1 | 4 | 1 | 49 | ........ | ........ |
| Monthly Letter | 12 | 192 | 12 | 214 | 2 | 42 |
| Total | 535 | 15,788 | 523 | 14,840 | 530 | 16,499 |

[a] Supplement to catalogue.

## PUBLICATIONS ISSUED.

The following list gives the titles of the new publications[a] handled during the year:

### SPECIAL AGENTS SERIES.

No. 172. Electrical goods in China, Japan, and Vladivostok, by R. A. Lundquist; 197 pages. Price, 30 cents.

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[a] These publications are sold only by the Superintendent of Documents, Government Printing Office, Washington, D. C., and the district offices of the Bureau of Foreign and Domestic Commerce.

No. 173. Shoe and leather trade of China and Japan, by C. E. Bosworth; 37 pages. Price, 5 cents.

No. 174. Markets for boots and shoes in Chile and Bolivia, by Herman G. Brock; 192 pages. Price, 25 cents.

No. 175. Construction materials and machinery in Chile, Peru, and Ecuador, by W. W. Ewing; 205 pages. Price, 20 cents.

No. 176. Furniture markets of Chile, Peru, Bolivia, and Ecuador, by Harold E. Everley; 165 pages. Price, 25 cents.

No. 177. Boots and shoes, leather, and supplies in Argentina, Uruguay, and Paraguay, by Herman G. Brock; 182 pages. Price, 25 cents.

No. 178. Advertising methods in Cuba, by J. W. Sanger; 47 pages. Price, 10 cents.

No. 179. Boots and shoes, leather, and supplies in Brazil, by Herman G. Brock; 59 pages. Price, 5 cents.

No. 180. Far Eastern markets for railway materials, equipment, and supplies, by Frank Rhea; 339 pages. Price, 35 cents.

No. 181. Jewelry and silverware in Cuba, by S. W. Rosenthal; 78 pages. Price, 15 cents.

No. 182. Lumber market of Italy and reconstruction requirements, by Nelson C. Brown; 184 pages. Price, 25 cents.

No. 183. Furniture markets of Argentina, Uruguay, and Paraguay, by Harold E. Everley; 92 pages. Price, 20 cents.

No. 184. Electrical goods in Argentina, Uruguay, and Brazil, by Philip S. Smith; 133 pages. Price, 20 cents.

No. 185. Advertising methods in Chile, Peru, and Bolivia, by J. W. Sanger; 56 pages. Price, 10 cents.

### INDUSTRIAL STANDARDS.

No. 2. Standard specifications for carbon steel rails; 27 pages. Price, 5 cents.

No. 3. Standard specifications for open-hearth steel girder and high tee rails; 19 pages. Price, 5 cents.

No. 4. Standard specifications for low-carbon steel splice bars; 15 pages. Price, 5 cents.

No. 5. Standard specifications for medium-carbon steel splice bars; 15 pages. Price, 5 cents.

No. 6. Standard specifications for high-carbon steel splice bars; 15 pages. Price, 5 cents.

No. 7. Standard specifications for structural steel for bridges; 21 pages Price, 5 cents.

No. 8. Standard specifications for structural steel for buildings; 21 pages. Price, 5 cents.

No. 9. Standard specifications for structural steel for locomotives; 19 pages. Price, 5 cents.

No. 10. Standard specifications for carbon steel bars for railway springs; 13 pages. Price, 5 cents.

No. 11. Standard specifications for carbon steel and alloy steel forgings; 25 pages. Price, 5 cents.

No. 12. Standard specifications for quenched and tempered carbon-steel axles, shafts, and other forgings for locomotives and cars; 25 pages. Price, 5 cents.

No. 13. Standard specifications for carbon steel forgings for locomotives; 19 pages. Price, 5 cents.

No. 14. Standard specifications for carbon steel car and tender axles; 15 pages. Price, 5 cents.

No. 15. Standard specifications for wrought solid carbon-steel wheels for steam railway service; 21 pages. Price, 5 cents.

No. 16. Standard specifications for steel tires; 15 pages. Price, 5 cents.

No. 17. Standard specifications for steel castings; 21 pages. Price, 5 cents.

No. 18. Standard specifications for lap-welded and seamless steel boiler tubes for locomotives; 19 pages. Price, 5 cents.

No. 19. Standard specifications for lap-welded and seamless steel and wrought-iron boiler tubes for stationary service; 19 pages. Price, 5 cents.

No. 20. Standard specifications for welded steel pipe; 15 pages. Price, 5 cents.

No. 21. Standard specifications for boiler and fire-box steel for locomotives; 19 pages. Price, 5 cents.

No. 22. Standard specifications for boiler rivet steel; 15 pages. Price, 5 cents.

No. 23. Standard specifications for lap-welded charcoal-iron boiler tubes for locomotives; 15 pages. Price, 5 cents.

No. 24. Standard specifications for staybolt iron; 15 pages. Price, 5 cents.

No. 25. Standard specifications for engine-bolt iron; 15 pages. Price, 5 cents.

No. 26. Standard specifications for refined wrought-iron bars; 19 pages. Price, 5 cents.

No. 27. Standard specifications for wrought-iron plates; 13 pages. Price, 5 cents.

No. 28. Standard specifications for cast-iron pipe and special castings; 27 pages. Price, 10 cents.

No. 29. Standard specifications for cast-iron locomotive cylinders; 15 pages. Price, 5 cents.

No. 30. Standard specifications for extra-high-carbon steel splice bars; 15 pages. Price, 5 cents.

No. 31. Standard specifications for quenched high-carbon steel splice bars; 15 pages. Price, 5 cents.

No. 32. Standard specifications for quenched carbon steel track bolts; 15 pages. Price, 5 cents.

No. 33. Standard specifications for quenched alloy-steel track bolts; 15 pages. Price, 5 cents.

No. 34. Standard specifications for structural nickel steel; 21 pages. Price, 5 cents.

No. 35. Standard specifications for structural steel for cars; 19 pages. Price, 5 cents.

No. 36. Standard specifications for structural steel for ships; 19 pages. Price, 5 cents.

No. 37. Standard specifications for rivet steel for ships; 17 pages. Price, 5 cents.

No. 38. Standard specifications for billet-steel concrete-reinforcement bars; 17 pages. Price, 5 cents.

No. 39. Standard specifications for rail-steel concrete-reinforcement bars; 13 pages. Price, 5 cents.

No. 40. Standard specifications for cold-rolled steel axles; 15 pages. Price, 5 cents.

No. 41. Standard specifications for wrought solid carbon-steel wheels for electric railway service; 21 pages. Price, 5 cents.

No. 42. Standard specifications for automobile carbon and alloy steels; 23 pages. Price, 5 cents.

No. 43. Standard specifications for cold-drawn Bessemer steel automatic screw stock; 11 pages. Price, 5 cents.

No. 44. Standard specifications for cold-drawn open-hearth automatic screw stock; 11 pages. Price, 5 cents.

No. 45. Standard specifications for iron and steel chain; 19 pages. Price, 5 cents.

No. 46. Standard specifications for foundry pig iron; 13 pages. Price, 5 cents.

No. 47. Standard specifications for cast-iron car wheels; 21 pages. Price, 5 cents.

No. 48. Standard specifications for malleable-iron castings; 13 pages. Price, 5 cents.

No. 49. Standard specifications for gray-iron castings; 15 pages. Price, 5 cents.

No. 50. Standard specifications for hard-drawn copper wire; 25 pages. Price, 10 cents.

No. 51. Standard specifications for medium hard-drawn copper wire; 21 pages. Price, 5 cents.

No. 52. Standard specifications for soft or annealed copper wire; 15 pages. Price, 5 cents.

No. 53. Standard specifications for Lake-copper wire bars, cakes, slabs, billets, ingots, and ingot bars; 15 pages. Price, 5 cents.

No. 54. Standard specifications for electrolytic copper wire bars, cakes, slabs, billets, ingots, and ingot bars; 13 pages. Price, 5 cents.

No. 55. Standard specifications for spelter; 21 pages. Price, 5 cents.

No. 56. Standard specifications for manganese-bronze ingots for sand castings; 13 pages. Price, 5 cents.

No. 57. Standard specifications for purity of raw linseed oil from North American seed; 11 pages. Price, 5 cents.

No. 58. Standard specifications for purity of boiled linseed oil from North American seed; 11 pages. Price, 5 cents.

No. 59. Standard specifications for turpentine; 13 pages. Price, 5 cents.

No. 60. Standard specifications for carbon-steel and alloy-steel blooms, billets, and slabs for forgings; 19 pages. Price, 5 cents.

No. 61. Standard specifications for welded wrought-iron pipe; 15 pages. Price, 5 cents.

No. 62. Standard specifications for quenched and tempered alloy-steel axles, shafts, and other forgings for locomotives and cars; 25 pages. Price, 5 cents.

### MISCELLANEOUS SERIES.

No. 73. Economic reconstruction; 74 pages.

No. 74. Wearing apparel in Peru; 64 pages. Price, 10 cents.

No. 75. Statistics of German trade, 1909 to 1913; 71 pages. Price, 10 cents.

No. 76. International trade in footwear other than rubber; 93 pages. Price, 15 cents.

No. 77. Statistics of Austro-Hungarian trade; 64 pages. Price, 10 cents.

No. 78. Trade of the United States with the world, 1917–18. Part 1, Imports; Part 2, Exports. 458 pages. Price, part 1, 10 cents; part 2, 25 cents.

No. 79. International trade in cement; 76 pages. Price, 10 cents.

No. 80. Wholesale prices; 14 pages. Price, 5 cents.

No. 81. Selling in foreign markets; 638 pages. Price, 50 cents.

No. 82. Chemical and allied products used in the United States; 194 pages. Price, 25 cents.

No. 83. Trade directory of South Australia; 31 pages. Price, 5 cents.

No. 84. Commercial handbook of China, volume 1.

The editorial division was not adequately equipped to handle the suddenly increased volume of material that came in during the last six months of the fiscal year. And it has been in similar difficulties before, the reason being that, while money is at times readily forthcoming for field investigations, it is seldom available for the work of handling the resultant reports promptly. The proper distribution of information collected in the field is just as important as the field work itself and should be provided for just as carefully and as liberally.

## CHIEF CLERK'S OFFICE.

### ACCOUNTS SECTION.

The work of the accounts section consists chiefly of verifying accounts presented for payment, auditing the accounts of special disbursing agents, maintaining a record of the funds disbursed from the various appropriations under the direction of the Bureau, preparing statements as to the costs of the various investigations, instructing the field employees with regard to the method of rendering their accounts, conducting the correspondence with regard to all accounting and fiscal matters, and preparing data for the annual appropriation budgets.

There were passed for payment during the year 2.399 vouchers covering salary and traveling expenses of employees in the field, purchases of supplies and equipment, and miscellaneous services (not including vouchers covering purchases made by the division of supplies out of the contingent appropriation), as against 2,001 for the year ended June 30, 1918, 1,825 for the fiscal year 1917, 1,876 for the fiscal year 1916, and 1,700 for the fiscal year 1915. There were 3,982 letters written during the year as against 3,477 for the year ended June 30, 1918, 4,600 for the fiscal year 1917, 3,950 for the fiscal year 1916, and 3,700 for the fiscal year 1915. In addition, 278 travel orders and travel authorizations were issued, as well as numerous statements showing the condition of the various appropriations, expenditures made for the several investigations, and other fiscal matters.

While the work of the section was substantially increased, as a result of the increased appropriations, there was no increase in the clerical force of the section. Because of the increased work of the section there should be assigned to it at least one additional clerk with the ability to handle the accounts of special disbursing agents and the auditor's settlements of the accounts of the special disbursing agents. This clerk should be thoroughly familiar with the decisions of the Comptroller of the Treasury Department, as practically all of the auditor's settlements are based upon the Comptroller's decisions. This would relieve the chief of the section of an enormous amount of more or less routine work and permit him to devote more time to constructive work and other matters of an administrative nature than he is now able to do.

There was appropriated, for the fiscal year just ended, $125,000 for the commercial attaché service; $125,000 for the promotion of commerce; $100,000 for the promotion of commerce with Latin America; $50,000 for the promotion of commerce with the Orient; in addition to $154,120 for the salaries of the statutory positions in the Bureau and allotments of $6,200 for contingent expenses and $128,000 for printing and binding. In addition to these appropriations, the President allotted to the Bureau the sum of $325,000 from the funds of the appropriation for "national security and defense" to enable the Bureau to carry on certain war activities for which there were no available funds—making a total of $1,213,320 for the year, as against $737,670 for the preceding year. Out of these appropriations there were employed in the field during the year 192 persons, including the commercial attachés, their clerks, special agents, trade commissioners, commercial agents, and the employees in the district offices of the Bureau. A number of these were employed for only a part of the year.

All commercial attachés, special agents, and trade commissioners who are sent abroad to make special investigations or to study economic conditions are appointed special disbursing agents and must give bond satisfactory to the Department. Seventy of these employees disbursed funds as special disbursing agents during the fiscal year just ended, as against 49 for the preceding year. These special disbursing agents disbursed $322,308.58 during the fiscal year ended June 30, 1919, as against $203,247.23 for the preceding fiscal year. Funds were disbursed from the following appropriations by special disbursing agents during the fiscal year ended June 30, 1919:

| | | |
|---|---|---|
| Commercial attachés, Department of Commerce | 1919 | $111,398.65 |
| | 1918 | 6,227.67 |
| Promoting commerce, Department of Commerce | 1919 | 39,410.78 |
| | 1918 | 609.03 |
| Promoting commerce, South and Central America | 1919 | 44,600.15 |
| Promoting commerce, Far East | 1919 | 28,915.49 |
| National security and defense: | | |
| Commodity experts | 1919 | 88,525.80 |
| Import and export statistics | 1919 | 2,556.00 |
| Increase of compensation, Department of Commerce | 1919 | 46.25 |
| | 1918 | 18.76 |
| Total | | 322,308.58 |

It will be seen, therefore, that this particular branch of the work was practically doubled without any increase in the personnel of the section. Thirty-three of these special disbursing agents were appointed during the second half of the fiscal year, and the increased burden, therefore, fell within the period from January 1 to June 30, 1919.

### APPOINTMENTS WORK.

Among the special examinations held by the Bureau during the fiscal year ended June 30, 1919, were the following:

Trade commissioner (general investigations).
Commercial attaché.
Clerk to commercial attaché.
Commercial agent in district-office service.
Trade commissioner to investigate European markets for leather and raw-stock supplies.
Trade commissioner to investigate European markets for industrial machinery and construction materials.
Trade commissioner to investigate markets for electrical goods in Spain.

It is estimated that about 250 persons were examined for positions in the Bureau of Foreign and Domestic Commerce.

In former years the Bureau employed "trade commissioners," "special agents," and "commercial agents" to investigate trade conditions abroad and in the United States, and we were often asked the difference between these three classes of employees. As there was no essential difference, the Bureau has adopted the rule that in the future, in order to avoid any confusion on this point, the term "trade commissioner" will be used throughout the traveling-agent service and the term "commercial agent" will be confined to agents in the district-office service of the Bureau of Foreign and Domestic Commerce.

### DISTRIBUTION SECTION.

Approximately 2,000 names were added to the Exporters' Index during the year and 800 names removed. Approximately 565,000 copies of selling letters, 245,000 copies of confidential circulars, and 15,000 marked copies of the daily Commerce Reports were sent to names on this list. A number of requests were received from foreign firms for names of manufacturers of various articles, which were also supplied from this list.

Approximately 1,000 new lists were added to the lists of foreign firms interested in American manufactures, and there were about 4,000 individual requests for these lists, in some instances several hundred distinct lists being furnished on one request.

Seventeen Latin American circulars, 16 Far Eastern circulars, and 16 investors' circulars were sent out to names on the various lists especially maintained for these publications.

The revision of the Directory of Commercial Organizations of the United States for 1919 was begun, approximately 15,000 forms being sent to such organizations.

The following table shows the number of publications and circulars distributed by the Bureau during the fiscal years 1917, 1918, and 1919:

PUBLICATIONS DISTRIBUTED DURING THE FISCAL YEARS ENDED JUNE 30, 1917, 1918, AND 1919.

| Publications. | 1917 | 1918 | 1919 |
|---|---|---|---|
| Monographs: | | | |
| Special agents series | 22 | 24 | 16 |
| Special consular reports | 1 | 4 | 1 |
| Miscellaneous series | 16 | 10 | 18 |
| Foreign tariff series | 4 | 8 | 3 |
| Foreign tariff notes | 4 | 4 | 3 |
| Industrial standards | ...... | ...... | 62 |
| Confidential bulletins | 1 | 1 | 2 |
| Statistical publications | 55 | 57 | 57 |
| Confidential circulars | 51 | 16 | 52 |
| Press letters | 95 | 122 | 51 |
| Selling letters | 45 | 42 | 35 |
| Miscellaneous circulars | 11 | ...... | 3 |
| Annual report cf Chief of Bureau | 1 | 1 | 1 |

## APPROPRIATIONS AND ESTIMATES.

The table below shows the appropriations that were available for the fiscal year ended June 30, 1919, those available for the fiscal year ending June 30, 1920, and the estimates that are to be submitted for the fiscal year ending June 30, 1921. It gives the number of persons employed and the amount of money expended in each branch of the work. It will be seen that an appropriation of $1,658,420 is asked for the fiscal year 1921, this being an increase of $747,910 over the year 1920.

APPROPRIATIONS FOR THE BUREAU OF FOREIGN AND DOMESTIC COMMERCE DURING THE FISCAL YEARS ENDING JUNE 30, 1919, AND JUNE 30, 1920, AND ESTIMATES FOR THE YEAR ENDING JUNE 30, 1921.

| Appropriations and classes of work. | 1919 | | 1920 | | 1921 | |
|---|---|---|---|---|---|---|
| | Employees. | Amount. | Employees. | Amount. | Employees. | Amount. |
| Statutory appropriation: | | | | | | |
| Administration | 7 | $20,150 | 6 | $18,550 | 8 | $22,150 |
| Accounts, records, and files | 21 | 23,040 | 31 | 37,080 | 42 | 50,000 |
| Collating tariffs | 4 | 5,500 | 6 | 9,900 | 11 | 17,550 |
| Compiling statistics | 20 | 29,200 | 35 | 51,000 | 55 | 78,850 |
| Distributing information | 6 | 7,100 | 6 | 7,400 | 11 | 13,240 |
| Division of commercial attachés | 1 | 900 | 4 | 6,000 | 7 | 10,850 |
| Division of district offices | 1 | 1,200 | 2 | 3,700 | 5 | 8,750 |
| Division of field investigations | 5 | 4,600 | 6 | 7,820 | 9 | 12,270 |
| Editorial work | 10 | 15,000 | 15 | 21,700 | 24 | 34,550 |
| Latin American division | 3 | 2,820 | 2 | 3,200 | 1 | 1,400 |
| Research and translation | 14 | 22,010 | 15 | 24,660 | 23 | 33,560 |
| Trade information | 21 | 22,600 | 22 | 26,800 | 34 | 42,450 |
| Far Eastern division | ...... | ...... | 3 | 2,700 | 3 | 2,700 |
| Commercial intelligence | ...... | ...... | ...... | ...... | 7 | 9,600 |
| Total | 113 | 154,120 | 153 | 220,510 | 240 | 337,920 |
| Promoting commerce: | | | | | | |
| Field investigators | 23 | 27,610 | 83 | 164,417 | 60 | 241,900 |
| Miscellaneous | ...... | 5,500 | ...... | 6,500 | ...... | 7,500 |
| Maintenance of district offices— | | | | | | |
| Salaries in district offices— | | | | | | |
| Boston | 5 | 6,367 | 4 | 6,400 | 8 | 14,040 |
| Chicago | 5 | 5,538 | 4 | 6,400 | 8 | 14,040 |
| New Orleans | 3 | 2,785 | 3 | 5,200 | 6 | 10.840 |
| New York | 22 | 17,088 | 13 | 19,900 | 20 | 32,760 |
| San Francisco | 4 | 4,327 | 3 | 5,400 | 7 | 11,680 |
| Seattle | 3 | 4,219 | 2 | 2,200 | 7 | 11,680 |
| St. Louis | 3 | 3,111 | 2 | 3,200 | 6 | 10,840 |
| Detroit (contemplated) | ...... | ...... | ...... | ...... | 5 | 8,800 |
| Other district office expenses | ...... | 6,785 | ...... | 11,300 | ...... | 10,320 |

APPROPRIATIONS FOR THE BUREAU OF FOREIGN AND DOMESTIC COMMERCE DURING THE FISCAL YEARS ENDING JUNE 30, 1919, AND JUNE 30, 1920, ETC.—Continued.

| Appropriations and classes of work. | 1919 | | 1920 | | 1921 | |
|---|---|---|---|---|---|---|
| | Employees. | Amount. | Employees. | Amount. | Employees. | Amount |
| **Promoting commerce—Continued.** | | | | | | |
| Miscellaneous, including rent, traveling expenses, supplies, cablegrams, temporary clerical assistance, etc., other than district offices | | $41,670 | | $94,083 | | $125,600 |
| Total | 68 | 125,000 | 114 | 325,000 | 127 | 500,000 |
| Commercial attachés: | | | | | | |
| Salaries, commercial attachés, clerks, and expenses— | | | | | | |
| Denmark (Copenhagen) | 2 | 12,250 | 2 | 11,700 | 3 | 15,000 |
| France (Paris) | 2 | 6,300 | 2 | 11,650 | 4 | 16,500 |
| Netherlands (The Hague) | 1 | 7,900 | 2 | 10,300 | 3 | 12,000 |
| Italy (Rome) | 1 | 2,800 | 2 | 11,750 | 4 | 16,000 |
| Mexico (Mexico City) | | | 2 | 10,450 | 4 | 16,000 |
| Spain (Madrid) | 1 | 5,000 | 2 | 11,950 | 4 | 16,000 |
| United Kingdom (London) | 2 | 10,950 | 2 | 11,900 | 4 | 16,500 |
| Argentina (Buenos Aires) | 2 | 11,800 | 2 | 12,200 | 4 | 16,000 |
| Brazil (Rio de Janeiro) | 2 | 11,800 | 2 | 11,250 | 4 | 16,500 |
| Chile (Santiago) | | | 2 | 10,000 | 3 | 12,000 |
| Peru (Lima) | 2 | 9,250 | 1 | 1,200 | | |
| China (Peking) | 2 | 10,100 | 2 | 14,800 | 4 | 20,000 |
| Japan (Tokyo) | 2 | 11,900 | 2 | 9,200 | 4 | 15,000 |
| Germany (Berlin) | | | | | 4 | 14,500 |
| Russia (Petrograd) | 2 | 4,300 | 2 | 11,100 | 4 | 14,500 |
| Belgium (Brussels) | | | | | 3 | 12,000 |
| Switzerland (Berne) | | | | | 3 | 12,000 |
| Cuba (Habana) | | | | | 3 | 11,000 |
| Central America | | | | | 3 | 10,500 |
| Australia (Melbourne) | 2 | 3,500 | | | | |
| Miscellaneous, including contingent expenses | | 8,150 | | 15,550 | | 38,000 |
| Total | 23 | 125,000 | 27 | 165,000 | 65 | 300,000 |
| **Latin America:** | | | | | | |
| Office staff | 41 | 36,986 | 13 | 20,000 | 20 | 30,000 |
| Field investigators | 12 | 50,429 | 12 | 72,000 | 15 | 110,000 |
| Miscellaneous, including contingent expenses | | 12,585 | | 8,000 | | 10,000 |
| Total | 53 | 100,000 | 25 | 100,000 | 35 | 150,000 |
| **Far East:** | | | | | | |
| Office staff | 8 | 7,354 | 10 | 20,000 | 15 | 30,000 |
| Field investigators | 6 | 30,302 | 12 | 75,500 | 20 | 115,000 |
| Miscellaneous, including contingent expenses | | 12,344 | | 4,500 | | 5,000 |
| Total | 14 | 50,000 | 22 | 100,000 | 35 | 150,000 |
| **National security and defense:** | | | | | | |
| Special statistical work— | | | | | | |
| Field investigators | 29 | 10,754 | | | | |
| Miscellaneous | | 4,246 | | | | |
| Import and export statistics— | | | | | | |
| Office staff | 92 | 59,055 | | | | |
| Field investigators | 1 | 2,556 | | | | |
| Miscellaneous | | 38,389 | | | | |
| Commodity experts— | | | | | | |
| Field investigators | 53 | 105,200 | | | | |
| Miscellaneous | | 94,800 | | | | |
| Total | 175 | 315,000 | | | | |
| **Development of trade through motion pictures:** | | | | | | |
| Showmen and lecturers | | | | | 8 | 30,000 |
| Miscellaneous | | | | | | 39,000 |
| Total | | | | | 8 | 69,000 |
| **Post allowances: Miscellaneous** | | | | | | 100,000 |
| **Transporting remains of officers and employees: Miscellaneous** | | | | | | 1,500 |
| **Transportation of families and effects of officers and employees: Miscellaneous** | | | | | | 50,000 |
| Grand total | 446 | 869,120 | 341 | 910,510 | 510 | 1,658,420 |

The following table gives the number of employees in the Bureau of Foreign and Domestic Commerce during the years 1912 to 1920. It shows that in the fiscal year that has just closed the number of lump-sum employees was 333 and those holding statutory positions 113, while during the fiscal year 1920 the force paid from lump-sum appropriations will probably reach 188 persons, with 153 statutory employees:

EMPLOYEES OF THE BUREAU OF FOREIGN AND DOMESTIC COMMERCE DURING THE FISCAL YEARS 1912 TO 1920.

| Year ended June 30— | Promoting commerce. | | Promoting commerce with South and Central America.[a] | | Investigation of cost of production.[a] | | Commercial attachés. | | Promoting commerce in Far East. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Employees. | Appropriation. | Employees. | Appropriation. | Employees. | Appropriation. | Employees. | Appropriation. | Employees. | Appropriation. |
| 1912 | 11 | $60,000 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| 1913 | 12 | 60,000 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| 1914 | 16 | 60,000 | ........ | ........ | 13 | $50,000 | ........ | ........ | ........ | ........ |
| 1915 | 34 | 75,000 | 17 | $50,000 | 18 | 50,000 | 20 | $100,000 | ........ | ........ |
| 1916 | [b] 32 | 77,000 | 35 | 75,000 | 18 | 50,000 | 20 | 100,000 | ........ | ........ |
| 1917 | [b] 53 | 125,000 | 32 | 100,000 | 22 | 50,000 | 20 | 100,000 | ........ | ........ |
| 1918 | 52 | 125,000 | 32 | 100,000 | ........ | ........ | 20 | 109,000 | ........ | ........ |
| 1919 | [c] 68 | 125,000 | [c] 53 | 100,000 | ........ | ........ | 23 | 125,000 | [c] 14 | $50,000 |
| 1920 | [d] 114 | 325,000 | 25 | 100,000 | ........ | ........ | 27 | 165,000 | 22 | 100,000 |

| Year ended June 30— | National security and defense. | | | | | | Total lump-sum employees. | Regular statutory force of Bureau. | |
|---|---|---|---|---|---|---|---|---|---|
| | Import and export statistics. | | Special statistical work. | | Commodity experts. | | | | |
| | Employees. | Appropriation. | Employees. | Appropriation. | Employees. | Appropriation. | | Employees. | Appropriation. |
| 1912 | ........ | ........ | ........ | ........ | ........ | ........ | 11 | [e] 92 | [f] $110,600 |
| 1913 | ........ | ........ | ........ | ........ | ........ | ........ | 12 | [e] 88 | [f] 114,860 |
| 1914 | ........ | ........ | ........ | ........ | ........ | ........ | 29 | [e] 88 | [f] 114,860 |
| 1915 | ........ | ........ | ........ | ........ | ........ | ........ | 89 | 89 | 122,180 |
| 1916 | ........ | ........ | ........ | ........ | ........ | ........ | 105 | 86 | 119,280 |
| 1917 | ........ | ........ | ........ | ........ | ........ | ........ | 127 | 95 | 130,640 |
| 1918 | 24 | $125,550 | ........ | ........ | ........ | ........ | 128 | 113 | 154,120 |
| 1919 | [c] 93 | 100,000 | [c] 29 | $15,000 | 53 | $200,000 | 333 | 113 | 154,120 |
| 1920 | ........ | ........ | ........ | ........ | ........ | ........ | 188 | 153 | 220,510 |

[a] Exclusive of temporary employees.
[b] Including 2 positions in the Bureau provided for by appropriation act.
[c] Including temporary employees.
[d] In part estimated.
[e] Including 6 employees paid out of tariff appropriation; later transferred to statutory positions.
[f] Including tariff appropriation ($10,000).

## CONCLUSION.

Burwell S. Cutler was the Director of the Bureau during the entire fiscal year of 1919 reviewed in this report. During this period I was commercial attaché at London. Since my return to Washington and entry upon the duties of Director, I have had an opportunity to survey the present position of the service from the point of view of one who has been for several years one of its oversea representatives. In common with other members of the Bureau staff at home and abroad, I had appreciated the value of having at the head of the Bureau a man like Mr. Cutler, who had had a practical and successful experience as a manufacturer, with export business. He injected into the service the practical point of view of a broad-gauge business man. He was devoted to the Bureau and did much to develop it along lines in strict harmony with the best ideals of public service, being at the same time always mindful of the fact that the ultimate object was to give genuine assistance to American exporters. My own feeling is that the Bureau as he left it was doing the largest volume of useful work in its history. An extension of the work from year to year had been made possible by increased appropriations. The development of the Bureau's work was consistent during the periods when Mr. Baldwin, Mr. Pratt, and Mr. Cutler were, respectively, in charge.

It is a privilege to have the opportunity to guide the work of the Bureau during the present critical period for American trade. Its future should be greater than its past in proportion as there is a more insistent demand on the part of American business for its services.

Respectfully,

PHILIP B. KENNEDY,
*Director of Bureau.*

To Hon. WILLIAM C. REDFIELD,
*Secretary of Commerce.*

# REPORT

## OF THE

# DIRECTOR OF THE BUREAU OF STANDARDS

# NATIONAL BUREAU OF STANDARDS

Washington, D. C.

1919

## FUNCTIONS

**Development, construction, custody, and maintenance of reference and working**

**STANDARDS - - - - - - - - - - - -**

**and their intercomparison, improvement, and application in science, engineering, industry, and commerce.**

# REPORT

OF THE

# DIRECTOR, BUREAU OF STANDARDS.

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Department of Commerce,
Bureau of Standards,
*Washington, July 1, 1919.*

Sir: There is submitted herewith a report of the work of the Bureau of Standards for the fiscal year ended June 30, 1919.

## I. FUNCTIONS, ORGANIZATION, AND LOCATION.

Before describing in detail the various scientific and technical problems in which the Bureau of Standards is engaged, the following brief statement as to its functions and organization may be helpful to those unfamiliar with the subject of standardization in its broad and modern sense.

The standards with which the Bureau is authorized to deal may be conveniently classed as follows: Standards of measurement, standard values of constants, standards of quality, standards of mechanical performance, and standards of practice.

### 1. DEFINITION OF STANDARDS.

**Standards of Measurement.**

A standard of length may be taken as an example of a standard of measurement. It must be a length which is unchanging, reproducible, and capable of being compared with the working standards used in the most precise scientific work or with those used in commerce and industry. The fundamental standard must be subdivided and working standards prepared of these parts, and for the measurement of greater length standards must be prepared which are multiples of the fundamental standard. This process of subdividing and multiplying the standard involves difficulties as great as those met with in the preparation of the fundamental standard itself.

The construction of a set of standard weights from a single unit is also an illustration; a whole set of standard weights must be prepared before the standard weight of the Government can become available to the public. When the standard of length or weight has been found with as many desirable qualities as possible, and before the working standards of the subdivisions or multiples can be prepared, the question as to the method of comparison arises, which again involves the solution of difficult scientific problems in connection with the balance or the methods used. These balances range from that capable of measuring the thousandth part of a milligram to the large testing machine capable of measuring a load of thousands of tons. The complete range must be covered which involves not only a large number of working standards, all of which must agree with the fundamental standard, but apparatus suitable for the comparison of these standards with all of the lengths or weights found in practice.

These steps and equipment are absolutely essential in order to secure uniform measurements of length or weight throughout the country, and they have their counterpart in every quantity that has to be measured, whether it be length, weight, temperature, heat, light, or the various electrical measurements or other standards of measurement. These standards in one form or another are involved in practically every scientific investigation, industrial process, engineering structure, or commerical transaction.

### Physical Constants.

There are many fixed relations between physical quantities, the values of which it is extremely important to know. These values are usually termed "physical constants," and are used in every branch of scientific work or industry. The amount of heat required to change a pound of water into steam under normal conditions and the relation between heat and mechanical energy are two important physical constants; their values are used in practically every computation in connection with the designing of steam engines and boilers, the tests of their efficiencies, or the measurement of their output. The amount of heat required to turn liquid ammonia into vapor or the amount of heat required to melt a pound of ice are constants equally important in the refrigerating industries. The value of the relation between electrical and mechanical energy is involved in many commercial transactions concerned in electricity.

Accurate and authoritative values of these constants are just as essential as in the case of standards of measurement. Many of these now in use are old and obsolete and need redetermination by means of the best modern facilities for physical measurement. Their determination involves the most difficult and precise work in all branches of physics and chemistry—a fact not generally known by those not engaged in the scientific or technical work where these constants are used.

### Standards of Quality.

A standard of quality for a given material may sometimes take the form of a sample of that material with which other materials of the same kind can be compared, but this is generally a makeshift of the poorest sort. It is only resorted to in the absence of definite and reliable specifications in terms of measurable properties; that is to say, a standard of quality of a material usually takes the form of a specification or definition of its properties, involving, of course, the measurement of those properties by means of the usual standards of measurement. A certain kind of steel, a cement, a paint, an oil, or a paper or cloth is found by use to be good or poor. The questions then arise: Why is it good or poor? What are the physical or chemical properties or the particular combination of elements which make it of good or poor quality? How are its properties to be measured or its constituents determined? These are questions for the laboratory to answer and involve physical and chemical investigations of the most difficult sort.

A standard of quality for a given material necessarily takes into account the purpose for which the material is to be used. To set the standard too low results in losses, poor efficiency, and even loss of life; to make it too high may result precisely in the same thing; that is to say, the material must be suitable for the purpose intended, and the Bureau's investigations in connection with the properties of materials are to enable the user of these materials, first, to select intelligently the material best suited for the purpose; second, to specify it in terms which the producer can not mistake; and, third, to make the necessary tests to ascertain whether or not the material supplied is in accordance with the specifications.

The actual testing of materials by the Bureau of Standards to ascertain whether or not they comply with specifications is confined almost exclusively to Government purchases, but in making these tests (in which the Bureau has had the hearty cooperation of practically all the departments of the Government service) it is compelled to make many investigations concerning the properties of materials, their specification, and measurement. While this work is of great value in placing Government purchases on a correct business basis, the results of the investigations as to the properties of materials and the information gained in testing Government supplies are even more important to the general public and are distributed in the form of suitable publications.

The Bureau does not compete with private testing laboratories, but endeavors to assist them by the development of standard specifications, methods of measurement, and other matters where uniformity is desirable, much of which information, as stated above, is secured in connection with the testing of materials purchased by the Government and a close observation of their use.

The time is not far distant when it will be required that all materials bought or sold shall be as represented, but it should be kept in mind that this is impossible except in the case of those materials where proper standards of quality and methods of measurement have been developed. It must not be assumed that the purchaser or user is the party principally benefited in the development of such standards; on the contrary, the manufacturer, first of all, is interested in the quality of all things which affect the quality of his product; and while the Bureau's efforts in this field are devoted principally to the pointing out and measurement of those properties upon which the quality of the materials depends, it is to be regretted that its force and equipment are insufficient to render more assistance to manufacturers with a view to a direct improvement of those parts of the process upon which the quality of the output depends.

**Standards of Performance.**

The value of an instrument, device, or machine almost always depends upon the efficiency of its performance. In such cases it is necessary to state the performance desired or guaranteed in terms which are correct and susceptible of measurement. As in the case of standards of quality, the standard involved is more often in the form of a specification, but specifications are useless unless based upon correct scientific and mechanical principles and supplemented with a statement of the method to be used in ascertaining whether or not the specifications or guaranties have been complied with.

The performance of an engine or boiler, a pump, an electrical generator or motor, a weighing device, or a telescope can usually be measured, but the quantities to be measured and the method used must be specified correctly and understood by all the parties concerned in the construction, purchase, or use of such apparatus. To do this properly involves the use of standards of measurement, standard values of constants, and standards of quality. The Bureau of Standards does not attempt to cover this field completely, but only those cases where there is a lack of definite information upon which to base specifications and only to the more important classes of apparatus. To secure this information involves investigations quite as scientific in character and as difficult as in the case of other standards, as well as a knowledge of technical and manufacturing processes. In this field, as well as in the field dealing with the properties of materials, the Bureau has had the most hearty cooperation of the various Government experts, manufacturers, engineers, and the technical societies.

### Standards of Practice.

Standards of practice are generally involved in the enactment of laws when technical and scientific matters are concerned, in the ordinances relating to the regulation of public utilities, and in the establishment of building and safety codes. Like standards of performance, they are dependent upon standards of measurement and standards of quality and are of the most vital importance in questions pertaining to the welfare and safety of the public. In a field so broad the Bureau can only touch upon the more important aspects of the work, where national uniformity is desired—fields which can not be covered efficiently in private laboratories.

## 2. RELATION OF THE BUREAU'S WORK TO THE PUBLIC.

### Comparison of Standards of Scientific and Educational Institutions or of the Public with Those of the Bureau.

It is perfectly obvious, even to one unfamiliar with the subject, that the maintenance on the part of the Government of correct standards of measurement or quality or performance calls for continuous scientific and technical investigations of the highest grade, involving the most competent expert services and the best scientific equipment. When this is accomplished, there still remains the serious problem of making the results available and useful to the public.

The Bureau compares with its own standards of measurement the standards of measuring instruments of States, cities, scientific laboratories, educational institutions, or the public, for which a nominal fee is charged, except in the case of the National and State Government institutions. It gives advice concerning these standards or their use, whether it be in connection with the enactment of laws, regulations, or ordinances concerning the weights and measures of everyday trade or in connection with precision standards used in scientific work. It gives advice upon request to State and city officials, public-service commissions, and public-utility corporations regarding the standards of measurement, or quality, or performance involved in legislation or regulation pertaining to the public utilities.

### Work of the Bureau in an Advisory Capacity.

Many questions of disagreement between the public and utility companies as to matters involving the use of standards are referred to the Bureau for advice or adjustment, often avoiding unfair and inconsistent regulations, as well as long-drawn-out and expensive litigation. There is a great need on the part of the public for unbiased and reliable information pertaining to the standards entering into the regulation and sale of the services of public utilities. As far as possible, such information is given in the form of publications upon definite subjects.

The Bureau is constantly called upon to compare the weights and measures in use by State and municipal officials, as well as by the public in general, with those belonging to the Bureau. This work is of the greatest importance in bringing to the attention of the public the value of exact standards and the benefits derived through their use in ordinary life.

Likewise, a great many inquiries are received concerning the use of the various materials of construction, and the Bureau has frequently assisted in the preparation of specifications on which to base the purchase of such materials.

In the formulation of safety codes designed to govern electrical and other construction, the Bureau has taken an active part and has been represented on many committees dealing with such work.

## 3. RELATION OF THE BUREAU'S WORK TO THE INDUSTRIES.

### Assistance in Establishing Exact Standards of Measurement Needed in Industries.

It must not be inferred from the above that the Bureau's activities are devoted principally to the interests of the user or consumer. The fundamental facts regarding standards of measurement, quality, or performance are the very things which most deeply concern manufacturers; they are fundamentally concerned, either directly or indirectly, with the improvement of methods of production or the quality of the output. It may be said that the Bureau occupies somewhat the same position with respect to the manufacturing interests of this country that the bureaus of the Department of Agriculture do to the agricultural interests. Many industries are just beginning to realize the importance of precise methods of measurement and scientific investigation which, in practically every case, involve some kind of measurement.

It is upon quality as well as upon price that competition must finally depend, whether in domestic or foreign commerce. The use of exact methods and scientific results is the greatest factor in the improvement of quality, efficiency, or the development of new industries. The educational value of the Bureau's work in this respect is almost entirely unknown to the general public, and yet the

Bureau receives hundreds of letters, as well as many personal visits from manufacturers, seeking information as to standards of measurement, how to use them, how to measure the properties of materials, or as to the fundamental physical and chemical principles involved; also, what is of even greater importance, how to initiate and carry out scientific investigations and tests on their own account in their particular fields of work.

The importance of maintaining scientific institutions having to do with standardization and the application of precise measurements to the industries has been recognized by all the leading countries of the world. Great Britain maintains the Standards Department of the Board of Trade, which is in charge of the standards and inspection service of the trade weights and measures; also the National Physical Laboratory, whose functions include matters pertaining to scientific and technical standards, physical constants, and to some extent the properties of materials. The Laboratoire d'Essais of France, while not as extensive as the English institution, is charged with similar duties. Germany maintains three such institutions—the Normal-Eichungs Kommission, equipped with the buildings, personnel, and apparatus necessary in standardizing and controlling the weights and measures of trade; the Physikalisch-Technische Reichsanstalt, covering testing and investigations in connection with scientific and technical standards other than weights and measures; and the Prussian Government maintains the Materialprüfungsamt, a large institution devoted to the investigating and testing of structural, engineering, and other materials.

It is generally recognized that these institutions have been exceedingly important factors in the industrial progress of these countries.

### Performance of Tests and Investigations and Collection of Fundamental Data.

While the greater part of the Bureau's efforts were given up during the war to work in connection with the military departments of the Government, it was never before called upon to such an extent for advice and scientific data by the industries. Most of these questions arose out of the manufacture of equipment and material of a military nature, as a large number of firms entered into this work during the war without any great amount of previous experience. A great many of these requests came directly from the manufacturers, others through the War Industries' Board, and still others from various commissions having to do with the production and commercial aspects of the war.

Every section of the Bureau cooperated to a greater or lesser extent with the manufacturers of the country, and, as a result, closer relations have been established between the industrial plants and the Bureau. It is evident that this relationship will continue and become of great economic value; but, if the Bureau is to retain its high position in the various industrial fields and meet the rapidly increasing demands for its services, the greatest amount of support possible must be given to it by the industries.

### Training of Experts in Various Industrial Fields.

Through the increased activities of nearly all the industries of the country and the demand for trained investigators, the Bureau's scientific staff has been largely depleted, and it will be a matter of some time before it can be brought back to the plane of high efficiency which it has previously maintained. It is assumed that the compensation paid scientific and technical men in the Government service will be adjusted to a scale more commensurate with that paid by scientific institutions and industrial laboratories, but even then the industries should cooperate in every way possible to maintain the Bureau's staff intact and of the best material. Many instances could be given where the industries have taken experts with little warning and with no apparent consideration as to the consequences. The training of men for research is one of the most important ways in which the Bureau can aid the industries; but to do this it is necessary to maintain its own staff in the highest degree of efficiency.

## 4. RELATION OF THE BUREAU'S WORK TO THE GOVERNMENT.

### Comparison of Standards of Other Government Departments with Those of the Bureau.

The use of exact standards enters into every branch of the Government service, as it does into every industry and into the everyday life of all persons. It was in the Government service, however, that the need for exact standards was first appreciated. The work done for the Government is in nowise different from that carried on for individuals and involves the same problems.

Many bureaus of the Government service are charged with the administration of laws and the establishment of regulations, the intelligent application of which depends very largely on the use of exact standards. This is true to a greater extent than is generally supposed. The Bureau of Standards has cooperated freely with such branches of the Government, and the service rendered has involved every department of physics and chemistry covered by the Bureau's activities. The neglect of such matters in the past has been a frequent source of misunderstanding and litigation between the Government service and the public. Conspicuous examples of bureaus to which such assistance has been given are the Customs and Internal-Revenue Services, Steamboat-Inspection and Coast Guard Services, and the Bureau of Navigation of the Department of Commerce, as well as all bureaus of the War and Navy Departments engaged in construction or development work.

### Performance of Tests and Investigations and the Collection of Scientific Data of a Fundamental Nature.

The engineering and building construction in progress at all times by the Government is exceedingly great, both in variety and magnitude, in all of it a knowledge of the materials employed is of fundamental importance from the standpoints of economy, efficiency, and safety. The work of investigating the properties of structural materials was taken up and is carried on primarily for the purpose of securing the information needed by the Government service in its structural work. This information is as necessary to the public in construction work, and every effort is made by the Bureau to make its findings in a form available to the public generally. The demands for information of this sort have come from practically all Government bureaus and establishments, but especially so in connection with the structural work carried on by the Office of the Supervising Architect, the engineering branches of the Army, the Bureau of Construction and Repair of the Navy, the Panama Canal, and the Reclamation Service.

### Advisory and Consulting Capacity.

One of the most important services which the Bureau has been able to render to other departments of the Government, both civil and military, has been of an advisory and consulting nature in matters pertaining to the scientific work in which these departments were interested. Too great emphasis can not be placed on the importance of this phase of the Bureau's work. Its maintenance would be warranted for this reason alone, even though its usefulness in this field is but a small portion of the total service which it has rendered other branches of the Government.

The Bureau's laboratories have been open and its experts available at all times to every department of the Government, and in many cases substantial help has been rendered to the military and civil departments through the familiarity of the Bureau with certain kinds of work, and its ability to quickly decide whether the particular methods, materials, or devices were suitable for the service in question.

### The Bureau as a Testing Laboratory and Its Work in the Preparation of Specifications on Which to Base the Purchase of Materials.

The Bureau of Standards serves as a testing bureau for the various departments of the Government when called upon; and, as such, is assisting to place Government purchases upon an economical and businesslike basis. The example of the Government in such matters has a far greater influence upon the public than is generally supposed. The Government can do no greater service to the country than to place its own purchases upon a basis which may be taken as a standard by the public at large. This work involves the specification of a wide range of structural and miscellaneous materials and their testing, when delivered, to ascertain whether or not they comply with the specifications. This is especially important, since such materials are purchased by means of competitive bids, a method resulting in much fraud and injustice unless suitable standards are established and successful bidders held absolutely to this standard in making deliveries. Furthermore, most purchasing officers are realizing the great importance of having such testing done by a disinterested institution equipped with the scientific and other facilities for performing the service in a manner that is fair to both parties concerned in the purchases.

Among the Government bureaus and establishments which have utilized the Bureau of Standards as a testing institution in connection with the purchase of supplies, may be mentioned the Government Printing Office, in connection with the purchase of paper, inks, and printing supplies, and the Post Office Department, in connection with the purchase of paper, twine, textiles, etc. A wide range of materials has been tested for the Quartermaster Corps of the Army, the Bureau of Supplies and Accounts of the Navy, and the Panama Canal. The General Supply Committee has called upon the Bureau for assistance in the specification of all sorts of supplies and equipment, as well as the testing of samples submitted by bidders of the supplies bid upon. Practically every branch of the Government service, including the District of Columbia, utilizes the Bureau of Standards as a testing bureau. Here, again, as in other fields of the Bureau's activities, it gains much useful knowledge, which is given to the public in the form of suitable publications.

## 5. RELATION OF THE BUREAU TO THE MILITARY SERVICES DURING THE WAR.

### Aid in the Development of Devices for Military Purposes.

The war brought about the most rapid and intense application of science the world has experienced. Scientific research received a stimulus that extended far beyond military fields and produced results of great permanent value to the industrial, as well as the military, world. The Bureau cooperated with the Army and Navy in the solution of their scientific problems relating to the development of all sorts of devices for military purposes, and was frequently called upon for advice by those manufacturers who during the war entered the field of producing military equipment for the first time. The experience gained through the investigation of these problems had many useful applications in the fields of industry without in any way revealing the military nature or value of the particular results sought.

The Bureau was exceedingly fortunate in securing substantial appropriations from Congress for carrying on work of this character in cooperation with the Army and Navy. The various bureaus of both these departments not only devoted funds to scientific research wherever necessary, but their cooperation with the Bureau of Standards was all that could be desired, and they should be given the greatest credit for utilizing the resources of the Bureau to their fullest extent.

Many cases might be cited where the Bureau undertook the development of military devices by its own staff or in cooperation with the experts of the Army, Navy, or manufacturers. A few characteristic and important examples which may be cited are: The development of sound-ranging devices in cooperation with the Engineer Corps of the Army; the production of an electrical device for synchronizing airplane machine guns and propellers; the application of the radio compass to both air and water navigation; the development of instruments for the navigation of air craft; the production of a hydrogen detector for submarines; and the development of all sorts of optical instruments for purposes of observation, range finding, and navigation. Work in cooperation with the Inventions Section of the General Staff has resulted in great improvements in the design of rifles, machine guns, and many other devices for like use. An elaborate investigation of methods of signaling by the use of invisible rays and the development of devices for the detection of secret writing may likewise be cited. In the field of aeronautic power plants, a special carbureter for air-craft engines and a high-speed gas-engine indicator were developed, together with other devices for aviation use. A great deal of work was done in connection with aerial photography for the Signal Corps, and, as a result of this investigation, a special hypersensitized plate was produced.

### Development of New Materials.

As mentioned in the preceding paragraph, the stimulus of the war was felt in every branch of the industries. Not only were new devices produced for military purposes, but certain entirely new materials were developed. The shortage of raw materials in certain lines, caused by the cutting off of the supply from Europe, led scientific men to turn their attention to the production of satisfactory substitutes, and to the use of many familiar materials for novel purposes. Thus the manufacture of optical glass in this country (a material formerly produced only in Europe) was proven to be a commercial proposition through the elaborate investigation which had been carried on by the Bureau even before the war. In like manner the shortage of linen led the Bureau to develop a satisfactory cotton fabric for use in covering airplane wings. A filter paper for gas masks was produced, and many specifications were prepared for all sorts of materials, such as prepared roofings, wall board, plaster board, cement, concrete, etc. New paints, designed for the protection of the interior of shells, the holds of vessels, as well as waterproof glues and varnishes, were developed through the Bureau's efforts. In all this work the Bureau cooperated with the military departments and the manufacturers, often acting merely in an advisory capacity, but more frequently carrying out complete investigations in each of the particular lines. Here, again, the information gained in reference to materials for military work has even a greater value in connection with the industries. There are few cases where the military and industrial interests were not equally important.

### Activities in the Field of Aeronautics.

The Bureau has engaged in researches and tests in connection with the determination of important fundamental data needed in aeronautics; the investigation and test of instruments, devices, and materials used in air craft for the air services of the Army and Navy, the National Advisory Committee for Aeronautics, the Bureau of Aircraft Production, and for manufacturers—a service which has resulted in great permanent value to both military and civil aeronautics and to those employing internal combustion engines.

This work has included tests in the altitude laboratory on various aeronautic engines to determine the variation of horsepower with altitude, compression ratio, and air temperature; the value of supercharging devices designed to enable airplanes to attain higher altitudes; the comparative values of various aviation fuels; the preparation of specifications for special aviation gasoline; and the relative merits of different carburetors, radiators, and other apparatus. A complete investigation of airplane ignition systems, including tests of magnetos and spark plugs, the development of a special improved spark-plug porcelain; investigation of the strength of materials used in the construction of airplanes; tests of all kinds of aeronautic instruments and development of certain special devices; aerodynamic tests of aerofoils and model airplanes; tests and the preparation of specifications for lubricating oils; tests of fabrics and airplane wings, and the development of a satisfactory cotton fabric; investigation of devices for synchronizing machine-gun fire with airplane propellers; study of self-luminous materials for use on the dials of aeronautic instruments; routine tests and development of special varnishes for airplanes.

### Activities in the Field of Metallurgy.

In this field the Bureau has cooperated with the Army, Navy, the National Advisory Committee for Aeronautics, and other military bureaus. The work has covered a complete investigation of aluminum alloys for use in the building of air-craft engines, etc., Government bronzes, development of special steels, investigation and development of satisfactory aluminum solders, and the preparation of specifications for bearing metals. A large amount of routine testing of gun steel and similar work was carried on.

### Activities in the Field of Electricity.

In the field of electricity the Bureau has continued to do a great deal of routine testing, including the acceptance tests of lamps and other electrical appliances for the bureaus of the War and Navy Departments. It has also carried on a number of complete investigations, among which may be mentioned the development of a satisfactory synchronizing device to be used in connection with machine guns designed to fire between the blades of airplane propellers, tests of electric trucks and tractors, development of radio apparatus, and a study of the fire-control system in battleships. A special manual has been prepared for radio operators, and the possibilities for the improvement of means of insulating cable, such as those submerged in salt water, have been investigated. Many such cases could be cited.

### Activities in the Field of Chemistry.

In cooperation with the Gas Defense Service, the Bureau tested a number of materials for the construction of gas masks and studied the composition and effects of poison gases. A very large number of routine analyses were carried out for the various branches of the Army and Navy, these usually taking the form of acceptance tests of materials.

Owing to the shortage of suitable dyes for use in manufacture of Army uniforms, American manufacturers were early called upon to supply dyes from this country. The Bureau carried out an investigation of textile dyes and aided in the preparation of suitable specifications to be used in their purchase. It also assisted in the development of satisfactory methods for the testing of materials for Army uniforms as to dye fastness and other chemical properties.

Other work included the development of special paints, enamels, varnishes, and protective coatings and the preparation of specifications for the same. During the war a great number of buildings of a temporary character were erected, and, in connection with these, a very large quantity of prepared roofing was purchased. The Bureau undertook an investigation of this class of materials, and, as a result of the work, was able to furnish to the organizations interested a satisfactory specification for such roofing.

### Development of Optical Glass and Optical Instruments.

For a number of years the Bureau has carried on experimental work with a view to assisting in the manufacture of optical glass in this country. This has involved a rather complete investigation of manufacturing processes and the making of a considerable amount of glass in the Bureau's own shops, which was utilized for military purposes. The information thus gained in regard to the pots used and materials involved, the technique of the furnace, the molding, annealing, testing, and inspection of glass was given freely to those manufacturers who were engaged in the manufacture of optical glass to supply the large and sudden demand for it in the construction of military optical instruments. The Bureau's plant will be maintained on an experimental basis and should render valuable assistance in the maintenance of the optical-glass industry in this country. (The importance of this work was emphasized during the war, as the foreign supply of this kind of glass was practically cut off.)

The importance of optical instruments is, of course, recognized at all times, but during the war the demand for suitable binoculars and field glasses was unusually acute. The test of such instruments has been carried on for the Army and Navy, and, in general, American makers have turned out a very satisfactory product. The bureau has cooperated in the specification, testing, and standardizing of the optical instruments used in military work.

An elaborate investigation was conducted on the use of ultra-violet light for signaling purposes. By the use of a source of such light and a suitable glass through which to view it a means of signaling, invisible to the naked eye, was developed for the Signal Corps of the Army and the Bureau of Steam Engineering of the Navy. Unusually rapid photographic plates for airplane cameras were investigated and a satisfactory panchromatic plate developed.

### Organizations with Which the Bureau Cooperated During the War.

Civil organizations: Aircraft Board, Emergency Fleet Corporation, National Research Council, War Industries Board, National Advisory Committee for Aeronautics, United States Railroad Administration, Bureau of War Risk Insurance, American Red Cross, and others.

United States Army: Air Service, Coast Artillery Corps, Construction Division, Engineer Corps, Field Medical Supply Depot, Inventions Section General Staff, Motor Transport Corps, Ordnance Department; Purchase, Storage, and Traffic Division; Quartermaster Corps, Signal Corps, and others.

United States Navy: Bureau of Construction and Repair, Bureau of Ordnance, Bureau of Steam Engineering, Bureau of Yards and Docks, Hydrographic Office, Office of Naval Intelligence, various navy yards and naval bases.

## 6. ORGANIZATION.

The organization of the bureau's scientific and technical staff is based upon the nature of the expert service involved rather than upon the classes of standards. For example, the division of weights and measures has to do with all matters pertaining to standards of length, mass (weight, as it is commonly termed), time, density, and similar questions, whether they arise in connection with the precision standards used in scientific investigation, the master standards of manufacturers, or the ordinary weights and measures of trade. A standard of quality or performance where any of the above measurements form the fundamental and most important factor would be referred to this division.

The division of heat and thermometry has to do with heat standards, the testing of heat-measuring apparatus, the determination of heat constants, of which there are many, and all investigations pertaining to quality or performance where heat measurement is the essential and predominating factor.

Similarly, the electrical division is concerned with all the electrical problems that may be taken up at the bureau, whether in connection with the various electrical standards of measurement, electrical constants, the electrical properties of materials, or the performance of electrical equipment.

Questions in optics enter into standards of all kinds to a greater extent than has been supposed; hence, there is an optical division provided, with experts in spectroscopy, polarimetry (used in sugar analysis), color measurement, the principles of optical instruments, and the measurement of the optical properties of materials.

Practically all investigations concerning the various classes of standards involve chemistry in one form or another. There are also many chemical standards and questions which arise in connection with chemical work generally, especially in the industries; hence, there is a chemical division, cooperating with every other division of the bureau, as well as taking care of the questions of a purely chemical nature that come to the bureau and which fall within its functions.

In the case of the more important technical fields, divisions have been formed dealing more specifically with large and important classes of materials, but many of the purely scientific questions involved would be handled by one of the above-mentioned scientific divisions or jointly with it. The work of the technical divisions is just as scientific in character, but deals more specifically with manufactured products.

The work of the structural engineering and miscellaneous materials division includes the investigation, testing, and preparation of specifications for these materials, such as the metals and their alloys, stone, cement, concrete, lime, the clay products, paints, oils, paper, textiles, rubber, and other miscellaneous materials.

The division of engineering research makes investigations and tests regarding the performance and efficiency of such instruments, devices, or machinery as the Bureau may take up that do not fall directly under one of the scientific divisions. The division is a small one, and its work is devoted almost exclusively to assistance given other departments of the Government and the General Supply Committee in designing, specifying, or testing equipment. It should in time form one of the more important branches of the Bureau's work.

The questions pertaining to the manufacture, specifications, testing, and use of the metals and their alloys is so important that a division known as the metallurgical division was formed of the experts engaged in these problems.

The employees engaged in clerical work, purchasing, files, records, accounting, and library are known as the office division, while those employed in the operation of the mechanical plant, the various shops, and the care of the buildings and grounds form the engineering and construction division.

## 7. LOCATION.

The laboratories of the Bureau of Standards are located in the northwest section of Washington, on Pierce Mill Road, near Connecticut Avenue, and are reached by the Chevy Chase car line. They were located outside of the business center of Washington in order to insure freedom from mechanical, electrical, and other disturbances common to the business and more thickly populated sections of the city. Furthermore, the area of ground necessary precluded a site near the city. It has been found by experience that the efficiency of the employees, especially those engaged in testing and scientific investigation, has been greatly increased by the location of the laboratories in a section free from the ordinary disturbances of city life.

# II. SCIENTIFIC AND TECHNICAL DIVISIONS.

## 1. WEIGHTS AND MEASURES.

**[Length, area, volume, mass, density, pressure, and time, including researches on units and standards, measuring methods and instruments, specifications and tolerances, and the standardization incident thereto for inspectors of weights and measures, manufacturers of measuring appliances, scientific and technical laboratories, Government bureaus, engineers, and the general public.]**

### LENGTH.

**(The design, improvement, and investigation of length-measuring apparatus, calibration and test of yard bars, meter bars, geodetic tapes, level rods, hæmacytometer apparatus, cement sieves, expansivity of solids.)**

The urgency of the testing work for the military departments during the war led to the deterioration of the apparatus, which was corrected as soon as the opportunity offered itself. The condition of all of the comparators and standards was carefully studied, and steps were taken to place them in first-class condition.

The desirability of controlling the temperature of the room in the basement in which the meter comparator is installed has long been recognized, but for the reasons mentioned little progress in carrying out the plans had been made until the signing of the armistice released some of the energies previously tied up. During the year the interior of the room was insulated from the outer walls. Also a regulating thermostat and heating and cooling coils were either constructed in the shop or ordered from the manufacturers. It is expected that arrangement will make it possible to control the temperature in the room to within 0.5° centigrade. More perfect control of the standards at any time under investigation will be secured by placing them in insulated containers to protect them from fluctuations of the room temperature, the main consideration usually being that the two standards under investigation shall be at the same known temperature.

Investigations have also been conducted to determine the best method of illuminating the standards. The apparent shifting of the lines on the standards when the prisms mounted under the microscopes are moved was eliminated by placing a thin sheet of xylonite, one surface of which has been slightly roughened, under the prisms.

**Paint Films.**

Certain considerations have indicated that one element of proper specifications for paint should probably be the thickness of a coat of it on a metal plate under certain specified conditions. In a study of this subject by the chemistry division it was realized that in order for measurements of this film thickness to be practical a simple device must be employed. To that end experiments were made by this section which resulted in the conclusion that a dial gauge could be employed, a rather stiff and plane metal plate being used for the film of paint and measurements taken at various designated points both before and after the paint had been applied. Three points of support for the plate were suggested as preferable from a number of considerations. With a special device of this character the chemistry division has been continuing the investigation.

In a special test, films of the paint used on ordnance shells gave a very consistent series of results. One of the specific points in view was to determine whether the film was sufficient for protection and yet thin enough to insure that there would be no interference or rubbing when fired.

### Oscillograph Films.

An investigation of the accuracy with which oscillograph films used in ballistic work could be measured by different methods indicated the best methods of measurement and the accuracy to be expected. One of the singular facts, probably due in part to physiological and psychological causes, which was noted in this investigation, was that more accurate results seem to be obtained by moving the cross hairs of a micrometer microscope until a line, ruled on the object at the focus of the objective, is exactly between these cross hairs, than to move the object slowly until the line appears to be between the cross hairs. This would seem to have a rather wide range of application to many measuring devices and possibly to other instruments.

### Meter and Yard Bars.

The Canadian Government at Ottawa submitted one of their principal standards of length for a determination of the total length. As it had at some time previously been tested at the National Physical Laboratory in England, and, as a rather complete intercomparison of several meters belonging to this Bureau was made in connection with the Bureau's test, it is believed that the final results may give additional facts concerning the changes which may occur in a length standard during the course of time.

### Sieves.

Few articles tested by the Bureau have as wide a range of use as sieves. Among the users may be mentioned the cement, fertilizer, mining, metallurgical, abrasive, chemical, drug, and sugar industries. The attention of this section has been especially devoted to the finer-meshed sieves. In the case of 200-mesh sieves a very noticeable improvement in American-made cloth has been noted during this last year.

Because of the large amount of explosives used by the Government, and because of the need of rather strict specifications for the ingredients, this Bureau rendered considerable assistance in giving advice as to the proper specifications for the sieves and in settling various disputes which arose from the fact that in many cases there exist several distinct sieves of different make, all designated by the same mesh. In compliance with many urgent demands, the standard scale for testing sieves adopted in 1916 has been revised. In the revised scale not only the size of the openings, but also the diameters of the wires, form a regular and continuous sequence from the coarser to the finer sieves. The ratio of openings is $\sqrt[4]{2}$ throughout.

and each sieve is designated by a number approximately equal to the mesh per linear inch. This revised scale has been sent to those believed to be interested, and from the many favorable replies so far received, its early adoption seems assured. Although primarily intended as a standard for testing sieves its application is by no means thus limited, the rather strict tolerances being omitted or modified when the sieve is to be used for general routine or commercial sieving.

### Routine Testing.

The following is a list of articles tested by the length section during the year, with the fees charged:

| | Fee. |
|---|---|
| 12 meter and yard bars | $64.00 |
| 575 hæmacytometers | 930.00 |
| 152 sieves | 175.20 |
| 8 samples sieve cloth | 11.60 |
| 43 polariscope tubes | 17.60 |
| 6 viscosimeters | 18.00 |
| 27 level rods | 76.50 |
| 81 invar tapes | 224.50 |
| 128 metallic warp tapes | 95.25 |
| 114 steel tapes | 97.55 |
| 2 spring balances for tapes | .50 |
| 33 articles for contact measurements | 54.25 |
| 40 articles for line measurements | 197.00 |
| 8 articles for angular measurements | 19.50 |
| 3 Brinnel microscopes and 1 Ames dial | 8.00 |
| 42 miscellaneous articles for test | 75.00 |
| 10 miscellaneous articles for ruling | 100.00 |
| Total (1,234 articles) | 2,164.45 |

## MASS.

(The comparison of precision weights with the standards of the Government, the preparation of specifications and tolerances for weights and balances, improvement in design of balances, solution of fundamental problems arising in connection with weighing, precision weights, and balances.)

### A Publication on Weights.

The revised edition of Circular No. 3, "Design and Testing of Standards of Mass," was published in December. Besides the new regulations in regard to testing and fees, it contains detailed descriptions of the requirements as to structure and accuracy for the classes of weights now recognized by the Bureau and the purposes for which they are intended, also a considerable amount of information concerning air buoyancy and its effect on weighing, and a fairly detailed description of the methods used in calibrating weights, with forms for computing the corrections. The circular should be of use to anyone wishing to calibrate a set of weights from a few certified standards, as well as to those using Bureau of Standards' certified weights for very high accuracy weighing, and to people wishing to buy or make high-grade weights for various purposes.

### Advice.

A considerable amount of advice and information about balances and weights has been furnished orally or in writing to members of the Bureau and to men from other Government departments and from private organizations.

### Cooperation with the War Department and Others.

The section has cooperated with the War and Navy departments by making considerable numbers of miscellaneous weighings for them, including weighings of machine-gun parts, cartridges, etc., and by some loans. It has also aided other sections of the Bureau, both by making weighings for them, including a series of weighings on specimens for the thermal-expansion laboratory, and by lending balances and weights for occasional use.

### Work with the Bureau of Markets on the Problem of Grading Wheat.

The section has been cooperating with the inspection service of the United States Bureau of Markets in improving a device for determining the weight per bushel of wheat from samples, as a basis of grading it. In connection with this work four grain testers have been tested for the United States Bureau of Markets and one for the State of Kansas, and some improvements suggested and adopted. A large number will probably be tested during the coming year.

### Effect of Brittle Lacquer in Rendering Weights Unreliable.

That the loss of weight caused by brittle lacquer breaking off in ordinary careful handling may be large enough to be serious for some kinds of chemical weighing was shown by a retest of three sets of weights which had been in use for a short time only in the chemistry division of the Bureau. In several cases the loss was over a milligram for a single weight, although there was little appreciable wear except on the neck of the knob where the tweezers grip the weights.

### Unsatisfactory Weights.

Much delay and extra work has been caused by rejections made necessary by the inaccuracy of weights submitted for test. Most of the class S sets have contained weights which were out of tolerance when first submitted. This widespread inaccuracy and frequent cases of unsatisfactory finish—slivers, inadequate plating, brittle lacquer, etc.—are probably due in a large part to unsettled conditions caused by the war. The need of testing new weights is continuously being shown by the discovery of poorly constructed or seriously inaccurate weights.

### Effect of Variations in Humidity on a Sensitive Balance.

An investigation of the irregular and unreliable behavior during the spring and summer of a new assay balance (supplied by the maker in place of the one mentioned last year, which had proved unsatisfactory for the rapid testing of small analytical weights, for which it was bought) disclosed the interesting fact that this balance is highly sensitive to changes in atmospheric humidity. An exhaustive study to determine the exact seat of the trouble has been planned, but only a small part of it has been carried out as yet, owing to the pressure of other work. The failure of this balance has more than doubled the time required for testing the milligram weights of each "analytical set," since it has been necessary to return to the longer methods of calibrating to secure the required accuracy.

### Changes in the Precision Weighing Laboratory.

During the earlier part of the year the work was hampered by the confusion incident to interchanging the weighing rooms. The time spent in planning the details of the new weighing room resulted in an arrangement at once more compact and more convenient than the former one. Also temperature conditions are much more constant in the new room than in the old.

### Routine Testing of Weights.

The total number of weights tested during the year was 2,594, a decrease of about 5 per cent as compared with the year previous. Of these about 51 per cent were for private parties—mostly commercial companies—25 per cent were for our own Bureau, 5 per cent for the War and Navy Departments, 9 per cent for other branches of the Federal Government, especially the Treasury and the Department of Agriculture, and about 5 per cent each were for the States and for the educational institutions, respectively.

### Testing of Balances.

The number of balances tested was unusually large—36 as against 22 last year. These were mostly for various divisions of this Bureau.

### Visitors.

The growing interest of the general public in the work of the Bureau is shown by the increasing number of visitors who have come to see the precision weighing laboratory and its work. A record kept during several typical weeks in the spring shows that during that season the average number of visitors per month was about 90. The amount of time required to show them the laboratory totaled more than three working days each month. This does not include any of the large groups from schools which occasionally came through, nor those who were attending the Physical Society meetings or the Weights and Measures conference at the Bureau. During the four days of the latter conference there were 53 visitors, taking seven hours' time.

## CAPACITY AND DENSITY.

**(Design and improvement of apparatus and methods of test, preparation of specifications for, and testing of glass volumetric apparatus, capacity measures and hydrometers, measurement of density and thermal expansion of liquids, density of solids.)**

During the year the following apparatus was tested as to compliance with the specifications promulgated by the Bureau:

| Apparatus. | Number submitted. | Tested. | Passed. | Fee. |
|---|---|---|---|---|
| Burettes | 418 | 330 | 252 | $361.50 |
| Cylindrical graduates | 3 | 3 | ........ | 2.15 |
| Dilution pipettes | 1,353 | 1,325 | 1,076 | 1,153.20 |
| Flasks | 1,648 | 1,383 | 1,021 | 521.65 |
| Pipettes, transfer | 713 | 646 | 459 | 218.05 |
| Pipettes, measuring | 131 | 109 | 62 | 138.45 |
|  | 4,266 | 3,796 | 2,470 | 2,395.00 |
| Hydrometers | 1,042 | 1,023 | 853 | 1,165.25 |
| Salinometers | 180 | 180 | ........ | 90.00 |
| Special apparatus | 151 | 107 | ........ | 114.55 |
| Weighings | 56 | 56 | ........ | 28.00 |
| Density determinations | ........ | 262 | ........ | 262.00 |
|  |  |  |  | 4,064.80 |

Fifty-eight per cent of the volumetric apparatus submitted passed the test of the Bureau, while of that actually tested 65 per cent passed.

Of the hydrometers submitted for test, 82 per cent passed, while of those actually tested 83 per cent passed the test of the Bureau.

## GAUGE WORK.

**(Improvement in the design and use of munition and other gauges, origin and development of methods of test, manufacture and salvage of gauges, examination and test of gauges.)**

The gauge section was organized as a part of the division of weights and measures at the beginning of the war to provide facilities on a larger scale to inspect and certify limit gauges and precision-length standards and to assist in the solution of problems arising in connection with gauge work.

The staff of the section numbered about 140 on July 1, 1918, and had further increased to 225 in November of the same year. By July 1, 1919, the number had been gradually reduced to 55 members.

### Scope of Work.

Besides the routine testing of gauges at the Bureau in Washington, the section during the past year conducted branch laboratories; developed and manufactured Hoke precision gauges; improved, designed, and constructed gauge-testing apparatus; salvaged and manufactured limit gauges; stored, shipped, and conducted a clearing house for master gauges; conducted instruction courses for Government gauge inspectors; studied gauge and tolerance problems for the National Screw Thread Commission; and prepared and distributed communications and reports regarding such parts of the above work as are of general interest.

### Appropriation and Allotments.

The section carried on its work under an appropriation of $150,000 for gauge standardization. This was supplemented by allotments totaling $233,000 made "to take care of expenses in connection with the salvage and manufacture of master gauges for the inspection Division, Ordnance Department." Another allotment of $50,000 was made by the Engineering Division of the Ordnance Department for experimental work and manufacture of precision gauges.

### Gauge Testing.

The number and lots of gauges submitted for test, month by month, are shown in the following table, which includes the work at Washington and the three branches:

| Date. | Number of lots. | Number of gauges. | Date. | Number of lots. | Number of gauges. |
|---|---|---|---|---|---|
| July, 1918 | 413 | 5,733 | February, 1919 | 102 | 1,596 |
| August, 1918 | 523 | 5,513 | March, 1919 | 89 | 978 |
| September, 1918 | 488 | 5,050 | April, 1919 | 86 | 644 |
| October, 1918 | 660 | 5,813 | May, 1919 | 79 | 481 |
| November, 1918 | 521 | 5,984 | June, 1919 | 51 | 2,253 |
| December, 1918 | 478 | 4,218 | | | |
| January, 1919 | 218 | 2,367 | Total | 3,708 | 40,630 |

Of the above gauges about 45 per cent were classified as screw-thread, 45 per cent as plain, and 10 per cent as profile, fixture, and miscellaneous types.

During the war the inspection was handled with such dispatch that the average time between the date of arrival and completion of tests and reshipment was from three to four days.

### Branch Laboratories.

The three branch gauge-testing laboratories were located in New York City; Cleveland, Ohio; and Bridgeport, Conn. Each was equipped with facilities duplicating on a small scale the Washington laboratory. These branches served a large number of manufacturers in the industrial centers in which they were located and aided materially gauge production by making it possible for manufacturers to send sample gauges and work by messenger for immediate inspection. All of the branch gauge laboratories have been discontinued on account of the lack of funds.

### Development and Manufacture of Precision-End Standards.

In July, 1918, experimental work was begun to demonstrate the feasibility of mechanical production of precision-end gauges under the direction of the inventor, W. E. Hoke, and in cooperation with the Bureau's experts in optical methods of measurement, which are essential. (For details of this work, see report of the optical section.) An early set of samples of equal length with 0.000002 inch, flat within 0.000004 inch, and within 0.000008 inch of the desired size has proved the practicability of the method. Upon receipt of this report the Ordnance Department made an allotment to cover manufacturing cost and commissioned the inventor. Bureau machinery and other machinery and special apparatus purchased under the allotment was installed and manufacture begun. By the close of the year more than 3,500 gauges had been manufactured, accurate within 0.000005 inch, and assembled in sets the total value of which, compared to the price of the formerly imported gauges, exceeded the amount of the allotment. The cost of experimental work and all machinery purchased was in this manner virtually saved by the Government in the first year's production.

### Gauge Storage and Distribution.

Following inspection and acceptance by this Bureau of master gauges purchased by and for the use of the Ordnance Department, gauges were classified and stored to await shipping instructions to points where munitions were approaching completion and master gauges would be required in connection with their acceptance. Between two and three thousand gauges were stored and shipped monthly in this manner. After the general cancellation of munitions contracts all the remaining gauges at the Bureau, except three or four thousand, representing one of each type and size. were shipped to arsenals designated by the Ordnance Department. These remaining gauges are in possession of the Bureau, subject to call for reference purposes.

### Gauge Salvage and Manufacture.

During the year 487 new master and inspection gauges were manufactured, and 962 additional obsolete gauges were salvaged for the Ordnance Department to conform to revisions in the designs of munitions components for which the gauges were originally procured. This was done as exigency work in the gauge shop only when serious delay would result from the regular method of procuring gauges from outside manufacturers through obtaining bids and placing contracts, or when a small amount of work would salvage obsolete gauges and save the much larger expense of contracting for entirely new gauges.

Five additional lead testers were manufactured for the Ordnance Department during the past year, so that one machine has now been supplied for each of the principal arsenals.

### Instruction Courses.

Three two-week courses of instruction covering the measurement and use of our special gauge-testing apparatus and study of methods particularly adapted to field work were given at the Bureau. The courses were attended by a total of 50 supervisors and gauge inspectors, among whom were represented 13 district ordnance offices, 2 navy yards, 2 arsenals, the Motor Transport Service, and 4 large manufacturers having war contracts.

### Design and Construction of Apparatus.

The following new designs of gauge-testing apparatus have been made to embody the results of experimental work: Simplified projection lantern of short range with horizontal projection, ground-glass screen, and equipped with incandescent arc illumination; an improved and simplified balanced micrometer to be used for pitch-diameter measurements of thread gauges by the three-wire method; a mechanical indicator to replace the optical lever system on the Bureau's lead-testing machines; apparatus for the measurement of periodic lead errors in plug-thread gauges; a device for standardization of wire measurements.

Apparatus and instruments are under construction at the present time for all of the above designs. In addition to this work, the shop has built during the past year practically all of the special apparatus required for the Washington laboratory and branches.

### Research.

Research work has been carried out largely in connection with problems of the National Screw Thread Commission. Experiments have been made to determine suitable tolerances, allowances, and interference values for various classes of fit. Study has been made of methods of manufacturing taps and screw-thread gauges, together with the effect of errors in taps on the size and character of tapped holes. Proposed tolerance systems have been worked out, tabulated, and charted. Questionnaires have been prepared and issued, through which information has been secured from manufacturers and users of screw-thread products relating to current practices. Replies have been studied, classified, and tabulated.

### Reports on Communications.

The following mimeographed communications which have been prepared or revised during the year are available for distribution:

B461. Symbols for screw-thread notation and formulas.
B466. Procedure of tests and explanation of reports of munition limit gauges by Bureau of Standards.
B467. Gauge tolerances used by Ordnance Department, United States Army.
B506. Important screw-thread systems.
B507. Shop inspection of taper-thread gauges.
B510. Construction and operation of projecting apparatus for measuring screw-thread gauges and profiles.
B512. Interchangeability of United States standard and British standard Whitworth threads by diameter modification.
B513. Services available at the Bureau of Standards gauge laboratories.
B514. Drawings and explanation of drawings used in manufacture of pitch-testing device.
B516. Important European screw-thread systems.
B517. Thread form and clearance of thread gauges.
B519. The measurement of radii on profiles.
B520. Testing of flatness of gauging surfaces.

A number of articles regarding the work of the gauge section have appeared in various mechanical trade journals and scientific magazines.

### Program.

A large amount of valuable data have been collected relating to all phases of war-time gauge work of the Bureau. From experience it has been possible to advise manufacturers on a great many subjects relating to the proper design, inspection, and use of limit gauges. This work is being continued and will be supplemented by literature prepared and distributed in such a manner as to reach and benefit the largest number of manufacturers and interested parties possible. Standardization, research, routine testing of commercial gauges and standards, and development of measuring apparatus will form important parts of the future work of the gauge section.

## TIME-MEASURING DEVICES.

(Origin and improvement of methods of test, and the testing of watches, clocks, and chronometers, and preparation of specifications therefor.)

Practically the whole efforts of the time section have been devoted to the testing of timepieces for the United States Shipping Board. This work, unlike other work, began during the war, and was not discontinued at the signing of the armistice, as the original shipbuilding plans of the Government were not thereby greatly modified.

This section has completed the following tests during the year:

| Kind. | Number tested. | Length of test in days. | Fees. |
|---|---|---|---|
| Class A watches | 82 | 54 | $311 |
| Ship watches | 1,395 | 31 | 6,975 |
| Comparing watches | 1,360 | 16 | 1,360 |
| Stop watches | 1,996 | [a] 12 | 594 |
| Wrist watches | 200 | 12 | 50 |
| Deck clocks | 4,778 | 21 | 4,778 |
| Airplane clocks | 33 | 12 | $132 |
| Chronometers | 9 | 31 | 95 |
| Investigation | 2 | 31 | 10 |
| Master clock system | 1 | 100 | 5 |
| Total | 9,856 | ........ | 14,310 |

[a] Minutes.

Of the 82 watches submitted to the class A test, certificates were granted to 19, of which 17 were of American manufacture and 2 European; certificates were refused to 63 watches, of which 25 were of American manufacture and 38 European.

## GAS MEASUREMENT.

(Design and improvement of apparatus, and the investigation and improvement of methods of tests of gas meters and meter-proving apparatus and other instruments used in connection with the flow of gases; testing of meters and meter-proving apparatus.)

### Testing of Town-Border Natural-Gas Meters for United States Fuel Administration.

In connection with its program of conservation of the natural-gas resources of the United States, the United States Fuel Administration requested the Bureau to test the natural-gas meters established at the town borders of a large number of cities and towns of Kansas and Missouri. Accordingly, the Bureau sent into these States members of its staff, who during the months of November and December, 1918, and January, 1919, tested a total of 103 large meters. Of these 12 were proportional meters, 2 pitot-tube meters, 33 orifice meters, and 56 positive-displacement meters.

On the basis of the Bureau's findings and the price of artificial gas, it has been estimated that during 1918 several million dollars' worth of gas was lost by leakage in the distributing plants receiving gas through the the meters tested.

### Meters Tested in the Laboratory.

A considerable number of meters of miscellaneous types were tested in the laboratory. These meters were all for use in testing and research work by the War Department and various scientific institutions.

### Investigation of Claims of Tide Motor for Post Office Department.

Upon request of the Post Office Department, the Bureau examined the claims made for a tide motor which was being advertised through the mails. The exhaustive examination made of these claims showed them to be false, and, as a result, the use of the mails in advertising the device was prohibited by the Post Office Department.

### Consultation.

The Bureau has been consulted frequently by Government departments and others regarding the solution of gas-measuring problems and has usually been able to give material aid.

### Publications.

Household Weights and Measures, Miscellaneous Publication No. 39. This consists of a card designed to be hung in the kitchen, which contains a large amount of weights and measures information frequently of use in the household.

### Orifice-Meter Investigation.

Preliminary work has been commenced on the determination of the coefficients of orifice meters for gas measurement. It is planned to make a thorough investigation of this type of meter in order to correlate and verify the work previously done by various investigators. These coefficients involve accuracy of the measurement of large quantities of natural gas, air, and steam.

### Photographic Method of Detecting Camouflage and Changes in a Complicated Group of Objects.

The Bureau devised and developed, in cooperation with the United States Signal Corps and United States Air Service, a photographic method of detecting camouflage. The method consists of making two photographic negatives of the group of objects, one before the change and the other afterwards. A positive is made from one of the negatives, and this is superposed upon the other negative. If no change had occurred between exposures, the combination would form a field of practically uniform photographic density; but changes are plainly indicated by discontinuities of density. It is believed that the method has considerable commercial value for engineering work, detective work, etc.

## THERMAL EXPANSION.

(Determination of thermal expansion of various materials.)

The expansion of a number of special alloys and materials over considerable range of temperature were studied during the year. The curves of a number of these materials were determined for the first time, and consequently they constitute valuable contributions to the available scientific and technical data. Altogether 121 specimens were studied, the materials being as noted below:

| Material. | Number tested. | Schedule fee. | Material. | Number tested. | Schedule fee. |
|---|---|---|---|---|---|
| Copper alloys | 49 | $735 | Limestone | 1 | $25 |
| Steel | 32 | 1,876 | German silver | 1 | 33 |
| Porcelain | 23 | 784 | Hard rubber | 1 | 38 |
| Bakelite | 4 | 137 | Stellite | 1 | 55 |
| Marble | 4 | 82 | | | |
| Celluloid | 3 | 68 | Total | 121 | 3,933 |
| Molybdenum | 2 | 100 | | | |

Over one-half the above tests are in response to military requests.

### Researches.

*Porcelain.*—Most of the porcelains were tested in connection with the Bureau's spark-plug research conducted at Pittsburgh and Washington. Expansion data are very essential in this work, since it is necessary to have the expansion of porcelain matched by that of the metallic electrodes if cracking is to be prevented.

The 49 copper alloys are a part of the original 129 submitted in July, 1916, by the American Brass Co. as a cooperative research. There still remain 10 specimens in this lot.

*Dental Amalgams.*—An extended series of experiments on dental amalgams were conducted at the request of the Surgeon General of the Army. There are no definite specifications for these materials. Personal opinion and crude tests have been relied upon in the past in grading them. Because of the complexity and minuteness of the dimensional changes taking place during the amalgamation of alloys interference methods have to be employed to study them.

The net result of all tests has shown that many alloys sold as "balanced" or "according to certain principles" in no sense develop the qualities which are supposed to accompany such products.

Comparative results on 12 alloys submitted to the Surgeon General of the Army for purchase were recently completed. This will be used as a basis for making decisions until permanent specifications are written.

Permanent specifications are to be prepared by this Bureau, with the cooperation of the Research Institute of the National Dental Association.

*Dividing Engine.*—Finding it impossible to repair or improve the present equipment of dividing engines in use or to purchase satisfactory ones, the Bureau has begun the design of new machines for future use. A study has been made of the design and accuracy of existing machines, and from this it is hoped the Bureau will be able to improve its equipment of apparatus.

### New Expansion Furnace.

The new high-temperature (1,000° C.) furnace for thermal-expansion measurements has been installed and is giving excellent satisfaction. Numerous tests of steel and iron have been carried beyond the recalescence temperature and detailed information secured in this region.

By attaching the position wires in V notches cut in the side of specimens it has been found possible to eliminate the errors due to blisters which appear on specimens heated above 700° C.

### Publications.

Bulletin 15 will include a paper on "Thermal Expansion of Molybdenum" issued by this section.

A second paper, "Thermal Expansion of Porcelain, Phenol Products, Marble, etc.," is now in the hands of the editorial committee.

## COMMERCIAL SCALES.

(The testing of railroad track scales, elevator scales, mine scales, other commercial scales and weighing and measuring apparatus; specifications for and capacity rating of scales.)

### Mine-Scale Investigation.

The investigation of mine scales has been continued, and the work has been carried into several new fields, notably in Ohio, West Virginia, and Kentucky. There is a great demand for work of this character, and it is being pushed as rapidly as possible with the facilities at hand. Very bad conditions have been encountered and rectified in the various regions, and many complaints have been investigated and amicably adjusted. As a result, a better understanding between the miners and operators has been created and greater efficiency in this industry is thus being brought about.

In Maryland serious inaccuracies of scales were found in a number of cases, and faulty and unlawful methods of weighing and incorrect tare weights were found in use. In order to rectify these conditions, a number of cases were brought to the attention of the Grand Jury by the State's Attorney, and at his request representatives of the Bureau appeared before the Grand Jury and testified as to conditions found. A number of indictments were obtained, and the cases were tried in the State courts. Several convictions were obtained, while in other cases the defendants were found "Not guilty" on account of lack of knowledge as to the inaccuracy of their weighing equipment. The cases had the result of effectively demonstrating the necessity of regular tests, quieting the suspicions and discontent of the miners and clarifying the meaning of the State mining law.

**Railroad Track-Scale Investigation.**

The testing or railroad-track scales has been continued throughout the year, although it has been found impossible to keep the equipments in the field at all times on account of lack of sufficient funds for this work. The Bureau has continued to cooperate with the United States Railroad Administration under the terms of Circular No. 13 of that administration, and reports of all tests of track scales belonging to the railroad companies have been furnished to the regional directors and the Federal managers of the roads concerned. Many of these officials have been making a determined effort to improve conditions on their lines, and in these cases the recommendations of the Bureau have been promptly complied with. As a result, in some sections conditions have doubtless been very materially improved. Ten master scales on the various lines have also been inspected and tested in order to maintain the standard of weight of the test cars operated by the railroad companies.

While special attention has been paid to scales belonging to the railroad companies as mentioned above, nevertheless a number of industry track scales, especially where tests were requested by railroad companies and State departments, have also been tested in connection with this work. Track scales have also been tested for the Government, States, and cities.

A summary of tests made follows:

| Scales tested. | Number tested. | Correct. | | Incorrect. | |
|---|---|---|---|---|---|
| | | Number. | Per cent. | Number. | Per cent. |
| Railroad track scales | 352 | 153 | 43 | 199 | 57 |
| Industry track scales | 312 | 156 | 50 | 156 | 50 |
| Government, State, and city track scales | 17 | 4 | 24 | 13 | 76 |

The tolerance allowed on the track-scale tests is the same as in former years, namely, a maximum allowable error of 200 pounds in weighing a car of 100,000 pounds, gross weight.

Some idea of the extent of the distribution of the above work may be gained from the fact that scales upon the lines of 78 different railroads were included, tests being made in the District of Columbia and the following 32 States: Alabama, Arkansas, Colorado, Georgia, Idaho, Illinois, Indiana, Iowa, Kansas, Louisiana, Maine, Massachusetts, Michigan, Mississippi, Minnesota, Missouri, Montana, New Hampshire, New Mexico, New York, North Carolina, North Dakota, Ohio, Pennsylvania, South Dakota, Tennessee, Texas, Utah, Vermont, Virginia, Wisconsin, and Wyoming.

In addition to tests made above, some special investigations of locomotive scales have been undertaken at the request of the U. S. Railroad Administration at seven plants with which the latter has contracts for furnishing new locomotives. These locomotive scales are scales of special design for the purpose of determining load distribution on locomotive drivers. The work has been completed in 3 of these plants, 29 scales of this type having been tested. Many of these were found to be of faulty design and very seriously inaccurate.

### Inspection and Test of Other Weighing and Measuring Apparatus.

Inspections and tests of a number of weighing and measuring devices have been conducted in order to ascertain whether their construction and accuracy were suitable for the purpose for which they were intended. This work was done at the request of various Government departments, manufacturers, State officials, and others, and included the investigation of several new types of liquid-measuring pumps. Tests were also made of a number of large-capacity scales at the Washington and Philadelphia Navy Yards. Also early in the year, representatives of the Bureau made very extensive tests of the weighing equipment at the Government powder-manufacturing plant, at Nitro, W. Va., in order to enable that plant to get into production. In compliance with an urgent request of the War Department, a special investigation was made of the weighing equipments at the Government powder-bag-loading plants located at Woodbury, N. J., and Tullytown, Pa. These plants were just beginning to operate at that time, and, since they were constructed primarily to supply powder charges to the American Expeditionary Forces in France, it was important that they be equipped with the best weighing apparatus and use the best weighing methods, so that maximum production could be obtained. A detailed report was made of the conditions found, and recommendations were included which were immediately put into effect by the War Department officials.

### Standardization of Large Test Weights.

The large test weights—namely, 10,000 pound and 2,500 pound weights—which make up the 100,000-pound loads on each of the test cars Nos. 1 and 2, were brought to the Bureau of Standards for recalibration. Since these weights are carried inside of a freight car, they are not subject to change in weight due to excessive wear, loss of parts, etc., as is the case with the railroad type of scale test car and therefore do not require checking so frequently. However, there is a slight change in their weight due to wear of paint, oxidation of iron, etc., which makes recaliberation from time to time necessary.

All of the weights were repainted and adjusted. After this adjustment the probable error of each set of 100,000 pounds is 0.1 pound, or inaccuracy of 1 part in 1,000,000.

### Specifications for the Manufacture and Installation of Railroad Track Scales for Ordinary Freight-Car Weighing.

The entry of the United States into the war delayed the issuance by the Bureau of Standards of final specifications for railroad track scales, which had been previously issued in preliminary form for comments. The subject of railroad track scales was, however, a matter of too great economic and industrial importance to abandon entirely. After the war work had become organized and under way, it became possible to give increasing attention to track scale matters. The Bureau has always made it a point to cooperate with all who have a legitimate interest in this subject, including the officials of States, railroads, manufacturers, and private concerns.

The regional director of the United States Railroad Administration for the Northwest region called together a meeting in Chicago to discuss the specifications which the State of Minnesota had adopted and were planning to put into effect on December 1, 1918. On account of war conditions it was desired to postpone the date at which these would be effective, since to meet the specifications would hamper the railroads under war conditions. The representatives of the State of Minnesota agreed to this, and the purpose of the meeting was accomplished. Furthermore, there was an apparent spirit of cooperation present which was promising. As a result the regional director for the northwest suggested that a committee be formed for the purpose of harmonizing the specifications for railroad track scales prepared by different agencies. This suggestion was acted upon. The Bureau of Standards indorsed this as a practical means for progress and was represented on this committee. This work lasted a large portion of the year.

On this committee were represented the American Railway Association, the American Railway Engineering Association, the Railroad and Warehouse Commission of the State of Minnesota, the National Scale Men's Association, the Scale Manufacturers' Association, and the Bureau of Standards. This committee drew up specifications which met the approval of all of the members and embodied features which the Bureau of Standards, as a result of its experience in railroad track scale work, advocated as desirable and necessary.

It is believed that these specifications will be widely adopted and result in a standardization of railroad track scales throughout the United States to the extent that standardization is valuable, and will result in a marked improvement in railroad weighing.

### Specifications for Scales for Weighing Grain.

The subject of defining what constitutes proper and adequate facilities for weighing grain has recently assumed large importance, and hearings relating to this matter were held by the Interstate Commerce Commission under docket 9009, dealing with loss and damage claims for grain in bulk shipments. The Bureau of Standards cooperated in trying to solve the difficulties by having a representative on a committee organized for the purpose of drawing up specifications defining what constituted proper facilities for weighing grain. It was neither practical nor possible under the circumstances to make an exhaustive investigation of the matter similar to that which had been carried out by the Bureau for railroad track scales, but tentative specifications were drawn up which represented the best information available on the subject.

These specifications were submitted to the Interstate Commerce Commission, which in turn submitted them to a joint committee representing the shippers and carriers, formed for the purpose of agreeing upon just and practical rules to govern the settlement of loss and damage claims.

If these specifications are accepted by the shippers' and carriers' committee, the Bureau of Standards will probably give them its indorsement and issue them as a circular.

Railroad track scales for weighing grain have been studied by the Bureau in connection with its railroad track-scale testing equipment. Hopper scales and automatic scales are matters on which much work remains to be done before any decision can be reached as to just what equipment and installation is required to secure accurate results, and the best and most economical manner of designing, installing, and using such scales.

## WEIGHTS AND MEASURES LAWS AND ADMINISTRATION.

(Cooperation with States in the administration of weights and measures laws; promulgation of specifications and tolerances for apparatus, and of rules and regulations; enforcement of standard barrel laws; conducting weights and measures investigations; annual conferences of State and local officials on weights and measures.)

### Cooperation with States and Other Interests in Weights and Measures Administration.

On account of the very material increases in the cost of all necessities of life the need of efficient inspection of weights and measures in commercial use is being more and more strongly felt, and several States have recently enacted laws establishing State-wide inspection for the first time. Among these may be especially mentioned Texas, North Dakota, and South Dakota, all of which have established comprehensive laws. Other States have added to their general code on this subject, while still others are conducting investigations to find out what character of legislation is needed. In connection with this activity, the Bureau of Standards is receiving an increased number of requests for assistance in establishing State departments, in conducting field investigations in various localities, in passing upon types of weighing and measuring apparatus to determine its fitness for commercial use, etc. Enormous good would doubtless result from increased activity in these fields of work, but lack of appropriations make it impossible to accede to many requests, even of the greatest urgency.

As a specific instance of the character of assistance requested may be mentioned legislation recently passed in the States of Maine and Texas. In the former State this becomes of force and effect on July 1, 1920, and provides that after that date no weighing and measuring apparatus may be sold in the State which has not been approved by the Bureau of Standards. In the latter State any apparatus approved by the Bureau of Standards may be sold without a special certificate from the State authorities. Unless an appropriation can be obtained for this work it will be impossible for the Bureau to undertake it, since it would be futile to attempt such a task with the present staff and facilities available. As a result, laws designed to protect the merchants and consumers of this State will be nullified. Yet not only would the results of such an investigation be of assistance in the States mentioned, but to all other States as well, many of which would rely upon the Bureau for technical infor- of this kind. Desirable uniformity could thus be brought about.

Other States, among which may be especially mentioned Virginia, desire information as to conditions existing in order that a basis for weights and measures legislation may be obtained. In these cases also the Bureau is often unable to proceed on account of shortage of funds. The need of a special appropriation for carrying on the work of cooperation with the States in weights and measures matters is very urgent.

Representatives of the Bureau attended State conferences of weights and measures officials in Michigan and New York and gave addresses on subjects of interest to the delegates.

### Proposed Federal Legislation.

Congress has not enacted any legislation on the subject of weights and measures during the past year. However, the Bureau has been working on a draft of a bill designed to standardize flour, meals, and commercial feeding stuffs throughout the United States, upon the hundredweight basis. This proposition was first brought before Congress last year, and since that time work has been done in perfecting it so that in its present form it has the hearty indorsement of all interests concerned, including the Millers' National Federation, an association comprising the large majority of the flour producers of the country, the American Corn Millers' Federation likewise including a large majority of firms in this industry, and every State association of weights and measures officials where the bill was considered, including New York, Massachusetts, Indiana, Wisconsin, Michigan, and Maine. Briefly, the bill eliminates the 196-pound barrel and the cumbersome and nonuniform subdivisions thereof now standardized in the various States and substitutes in their place the 200-pound barrel, with subdivisions of 100, 50, 25, 10, 5, 4, 2, and 1 pound. If this bill is enacted into law, a long forward step in uniform standardization of packages will be obtained, and some of the most important foodstuffs sold in package form will be efficiently and adequately regulated.

### Twelfth Annual Conference on Weights and Measures.

In order to assist the various State and local departments enforcing weights and measures laws throughout the United States in obtaining the greatest uniformity and in maintaining the greatest efficiency in their work, it has been the practice of the Bureau in the past to invite all those officials and others interested to attend a general conference on weights and measures at the Bureau of Standards once in each year. On account of the war these meetings were discontinued in 1917 and 1918, but this year it was deemed advisable to resume them, and consequently the twelfth conference was held on May 21–24, 1919. Great interest was manifested in this meeting. It was more generally attended than ever before, and was in every way a success. About 180 official delegates and visitors attended, 29 States being represented. Perhaps the most important constructive action taken was the tentative adoption of a set of specifications and tolerances for liquid-measuring pumps used in the sale of gasoline. These specifications and tolerances had been prepared by the Bureau of Standards as a result of a comprehensive investigation made shortly before the war. In general, these pumps have not been adequately regulated in the past, and, as a result, short measure in the sale of gasoline has been very common. With a uniform system of specifications and tolerances in use it is believed that much more success will be obtained in coping with the situation. Enormous losses to the consumer can be thus prevented and competition put upon a fair and honest basis.

Resolutions were passed by the conference indorsing legislation empowering the Bureau of Standards to pass upon and approve types of commercial weights and measures and weighing and measuring devices manufactured or offered for sale in the United States; and approving the decimal weight flour bill now pending in Congress. The conference also went on record as favoring the sale of dry commodities by weight; the marking of net weight on wrapped hams, bacon, and other meats; the standardization of packages; and the metric system of weights and measures.

About 15 years ago the Bureau of Standards announced its intention of exercising its functions in such a way as to be of maximum assistance in regulating and improving the general condition of weights and measures in commercial use and the manner of sale of commodities, and as a first step in this direction there was inaugurated the annual conference on weights and measures of the United States. At this meeting the representatives of the States were informed that to accomplish the above end the Bureau would give all necessary assistance in building up State and local inspection departments. In the case of matters of such a nature that they should be administered by the Government, the Bureau would procure and enforce necessary Federal legislation. Finally. the Bureau would act as a general clearing house for weights and measures information and assist in coordinating the activities of the Government and of the various States, so that maximum efficiency of procedure would be obtained.

For some years thereafter the Bureau of Standards was the only Federal agency in this field and completely dominated it. Much valuable progress was made toward obtaining the objects sought. Field investigations were made in every State in the Union, and commercial conditions were thereby determined, a model law was drawn up and its introduction procured in numerous States, Bureau representatives appeared before State legislative committees in support of the legislation proposed, and it was enacted in a large number of States. Following this action Bureau representatives visited these States, helped to establish the departments, drew up tolerances and specifications for commercial apparatus for their guidance which were promptly adopted by a number of States, and did other necessary work along the original lines of cooperation proposed.

During this time, also, the Bureau undertook to procure needed national legislation. The Federal apple-barrel law, the standard-barrel law, and the standard lime-barrel law were enacted by Congress, statutes important in themselves and more important still as a percursor of other legislation to follow. The proposed law for the Federal standardization of type of commercial weighing and measuring apparatus was drawn up and introduced with the hearty approval of the States.

Notwithstanding these activities and achievements, the Bureau is slowly but steadily losing ground in this field, owing to the insufficient funds with which to carry it on.

In the meantime, the Bureau of Markets and the Bureau of Chemistry in the Department of Agriculture, with a corps of agents in the field and ample funds, have taken up this work and are now claiming it as their own field. The efforts of the Bureau have merely been successful in indicating to these bureaus the possibilities in the weights and measures field. They have procured legislation such as the Federal standard container act and are vigorously enforcing it, whereas the standard-barrel laws are entirely unenforced by the Bureau of Standards, due to the lack of funds to put any inspectors in the field to look after it. It is much the same in the case of State cooperation; the Bureau has no representatives in the field, while the Department of Agriculture has numerous traveling inspectors who visit the States and assist the officials on all occasions, even in weights and measures matters. Very recently the Bureau of Markets, under the terms of the Federal warehousing act, issued rules and regulations requiring that scales used shall be of types approved by the Bureau of Markets, a matter which distinctly belongs in the field of the Bureau of Standards.

The time has now come when the Bureau should prepare to go forward vigorously or else to turn over to others the whole practical question of inspection, and with it the related one of commercial standards. If Congress is unwilling to give the Bureau a fund to take care of the laws which it now has to enforce and to enlarge its functions so that the matter can be handled in an adequate and businesslike way, it will be better for the Bureau to withdraw from the field altogether.

The same is true, but to a lesser extent, in the track-scale work of the Bureau. In this it has reached a point where instead of going forward we are losing ground. Its appropriations for this work have not been increased since 1913, when the work was commenced. In addition, it is faced with constantly rising salaries and increased expenses of operation of all kinds, while the demands for tests from the States, Federal agencies, the railroads, and others, are steadily increasing. It was found necessary last year to lay up two of the equipments for months and allow several of the best-trained field men to leave the service on account of the lack of funds. The situation will probably be still worse during the present year. The preliminary work has been done, but conditions have been shown to be extremely bad and in urgent need of competent regulation. New organizations, such as the Eastern Weighing and Inspection Bureau, are being formed to do work which should be done officially. The time has now come in this field also when the Bureau must of necessity go forward and occupy this field of regulation or retire in favor of some organization which will be prepared to do this.

One step needed to strengthen the Bureau's position in this field is the establishment of a depot in Chicago or some other western railroad center. Its present activities are merely successful in showing the necessity of governmental supervision of the scales used in interstate commerce, and there are numerous indications that other agencies are planning to take upon themselves this work. In order to properly handle the situation, the Bureau should have at least a dozen stations strategically located throughout the country. Each of these stations should have a master scale and the necessary test cars and equipment to supervise the test of all track and grain scales in their respective districts. Eventually an appropriation of $500,000 or more may be required. This program can not, of course, be carried out in one or two years, but sooner or later the demands of farmers' organizations and others using railroad track-scale weights will be heeded by Congress, and that agency which occupies the largest part of the field and shows itself most competent to handle the matter will be designated by Congress to do so.

The position of the Bureau in this field is as strong as it is likely to be with its present facilities. As more State organizations are formed and the railroads consolidated the Bureau's position will become relatively weaker. It is therefore strongly recommended that every effort be made to secure the appropriation for the depot asked for last year and again this year without success.

## Routine Testing.

The routine testing in section 1, length; section 2, mass; and section 4, volumetric, of this division is from three to six months behind. This condition is due to the fact that for some reason, probably the recognition of the commercial importance of technical and scientific work brought about through the war, an increase has resulted in the use of certified apparatus of the kind handled by the sections mentioned above. Every effort has been made by those engaged in this work to promptly dispose of it, but it has been beyond their capacity. As the work is now conducted it only creates dissatisfaction and brings severe criticism upon the Bureau and its employees, which is unwarranted, as important research work has been abandoned to care for routine tests. Not only are needed researches and investigations halted, but the testing is not done with that care which should characterize all of the work of the Bureau.

The Bureau has issued circulars giving the fees, and has been doing this work for a number of years. It has educated the public as to the importance of using apparatus that has been certified by a competent authoritative agency, and it should continue to do this work so essential to American industries, if it can be done with credit to the Bureau, or at least without discredit.

If Congress does not deem it proper to provide for this work for which estimates will be submitted, it would be well to consider the proposition of placing it on a self-supporting basis. It is hoped, however, that this need not be done, since such a plan has many disadvantages and often leads to embarrassing circumstances.

## 2. ELECTRICITY.

**[Electromotive force, resistance, current, inductance, capacity, conductivity, insulation, magnetic permeability and hysteresis, radioactivity and radiocommunication, including researches on electrical units and standards, measuring instruments, and methods of measurement, and cooperation with standardizing committees of technical societies, with testing laboratories, the electrical industries, public-service companies, and public-utility commissions, municipalities, and engineers upon problems of standardization, including standards of adequacy, and safety of service.]**

### Scope of the Electrical Work.

One of the most important functions of the Bureau with respect to electricity and allied subjects is the establishment and maintenance of the fundamental standards upon which all electrical measurements are based, including cooperation with similar institutions in other countries so as to secure international uniformity. This includes the intercomparison of standards and extensive research in methods of measurement and the development and improvement of subsidiary and derived standards. These standards are utilized, and the results of the researches are immediately applied in the testing of reference standards and instruments for manufacturers, testing laboratories, universities, research institutions, electric utilities, utility commissions, engineering and other interests, and various agencies of the Government.

The testing of electrical instruments and apparatus is of two main classes: First, there is the standardization of reference standards and precision instruments for manufacturing and other institutions which themselves make or standardize instruments for commercial use or which conduct research work. It is through the work of such institutions that the measurements made in practice are referred back to the standards of the Bureau. Second, a limited amount of testing of commercial electrical measuring instruments, radio and photometric apparatus, magnetic materials, etc., is done, chiefly for the purpose of keeping the Bureau in touch with the needs of the industries, of developing methods, and of improving apparatus and materials. The greater portion of this testing is done for the Government services, and serves the double purpose of providing information to be used in formulating specifications and of determining the quality of materials furnished upon them.

The research work has mainly to do with methods of measurement, the determination of the electric and magnetic properties of materials, and the development of those phases of engineering science in which measurement plays an important rôle. Electrical, radio, and illuminating engineering interests are all served by these investigations. The Bureau also renders important service, both directly and indirectly, to manufacturing and other industries. Much of this investigational work is on the more fundamental aspects of the principles involved, so that the results may be applicable to a class of problems rather than being limited to the one specific problem under investigation. The work on correlation of magnetic and mechanical properties of iron and steel and in the study of galvanometers are examples.

The research work in radiocommunication, magnetism, radioactivity, and photometry is along lines quite similar to that in the more purely electrical measurements. Standards have been and are being developed, methods of measurement are being improved, and important special problems of significance to the industries, and in a number of cases of particular importance to the Government, are being investigated. Specific examples of the projects in hand during the past year are given in the sections below.

## Special Military Work in Electrical Subjects.

During the first half of the year the demands for service to military departments were so numerous both in testing and in research that the resources of the electrical division, like those of other parts of the Bureau, were very largely devoted to such service. This involved an increased amount of work similar to that performed in ordinary times, including consultation with other departments on a larger number of technical problems. Extensive experimental investigations of a few important military problems begun during the preceding year were also actively continued.

Since the cessation of hostilities attention has naturally been turned to the revival of the normal work of the Bureau, but a large amount of time has been required to bring the military work to a satisfactory conclusion and to put the results in such form that the labor already expended should not be lost. Furthermore, many of the investigations begun on account of military needs are equally important in times of peace, and even equipment specifically developed for military use has in some cases been found applicable to industrial needs. These considerations have made it appear inadvisable to cut off immediately the activities which arose from the war, and it is hoped that means will be found to continue permanently some of the more important of these activities without sacrificing the fundamental work in electrical research previously carried on.

## Standardization of Electrical Equipment and Supplies for the War Department.

In order to simplify the handling of purchases of equipment and supplies for the War Department, the Standardization Section of the Purchase, Storage, and Traffic Division, General Staff, in August, 1918, appointed a committee on standardization, consisting of one member from each bureau of the War Department and one from the Bureau of Standards. This general representative of the Bureau was designated from the electrical division; and while some subcommittees of the general committee on standardization dealt with supplies of other kinds and called on many sections of the Bureau for information and assistance, the most active work was done in cooperation with the various subcommittees on electrical supplies. To this work three members of the Bureau staff gave practically all their time for several months, while a number of others contributed materially to the work of committees in their special fields.

Through the activities of the Bureau representatives the standardization committee was brought into touch with war-service committees of the various branches of the electrical industry, and a plan of discussion of proposed schedules and specifications was adopted which gave all interests concerned an opportunity to present their views to the committee. A close-working connection with the subcommittees of the standards committee of the American Institute of Electrical Engineers was also established through the Bureau's representation on that committee, and their assistance was obtained in the preparation of a considerable number of specifications for apparatus and material.

A considerable amount of testing was also required in connection with this work. Some of this was of routine nature as regularly carried on by the various sections of the electrical division, but other tests constituted rather extensive investigations, such as those on trucks and tractors and the storage batteries used in such vehicles and on protective lighting equipment. These are described later under the appropriate sections.

The results of all this standardization work were incorporated in a catalogue of supplies for War Department purchases which has been issued by that department. In several fields the work done emphasized the need of further extensive investigations, and the Bureau has been specifically requested to undertake investigations on miniature electric lamps, transformers, electric fans, storage batteries, stranding of cables, and insulation problems in connection with rubber-covered wires and cables, which would involve a large increase in its work in all these fields. Some of these investigations it is planned to undertake, but the adequate handling of most of them must await an increase in the resources available for the work.

## STANDARDS OF RESISTANCE.

**(Maintenance of fundamental standards of electrical resistance, calibration, and development of practical resistance standards and apparatus, testing of conductors and of conductivity of materials, galvonometer design.)**

With the exception of necessary work in routine testing of apparatus and materials, this section has given all its time during the past year to special problems arising from the war, the more important of which are described below.

### Nondestructive Tests of Welds.

Some method by which the quality of welds, especially welds in ship plates, may be determined without the destruction of the weld has been very much needed. It has been suggested that if the electrical resistance of such welds could be measured it would give an indication of the quality of the weld without destroying it. Such measurements, however, were considered impracticable, if not impossible.

An investigation was made which showed that with a current and potential terminal on either side of the weld and all four terminals fairly close together the resistance of a small portion of the plate, including a part of the weld, could be determined rather easily with the accuracy required. For example, a saw cut extending a quarter of the way through a half-inch plate could be easily detected by this means from either side of the plate. However, it appears that plates poorly welded may make excellent electrical connection with each other, and consequently the resistance method is not successful as a means of determining the quality of such welds.

### Control of Airplane Guns.

At the request of the Division of Military Aeronautics and the Inventions Section of the General Staff, this section of the Bureau undertook an investigation of the possibility of using electrical means for the control of airplane guns which must shoot between the blades of the propellers. The time between successive passages of the propeller blades through the same position is about 0.02 second. It is, therefore, necessary that the shots be timed with respect to the time of passage of the blades through the line of fire to better than 0.02 second. That is, the control apparatus must perform its function, the firing mechanism of the gun must operate, the primer explode, the charge explode, and the projectile pass through the barrel and past the propeller in less than 0.02 second if the apparatus is to operate at all speeds without compensation for changes in speed.

An electrical-control apparatus was developed which performs its function in a few thousandths of a second, so that the over-all time of action, up to the passage of the projectile 4 feet beyond the muzzle of the gun, is about 0.01 second. This type of gun control has many advantages over the mechanical and hydraulic types generally used, and further development incidental to its use with various types of gun is being carried out by the Division of Military Aeronautics with the cooperation of the Bureau.

### Action of Browning Field Gun.

At the request of the Ordnance Department of the Army, an investigation of the action of the Browning field gun was made for the purpose of finding out whether faulty action of the reciprocating parts was responsible for excessive breakage of the casing which was found to occur in service. The relative positions of the three principal reciprocating parts were determined throughout their cycles of operation, both when the gun was operated by hand and when it was firing. The results obtained showed that throughout the cycle each of these parts remained in a proper position with respect to the others and that consequently their action was presumably not the cause of the breakage. The methods used in this investigation were largely electrical and involved the services of electrical experts.

## INDUCTANCE AND CAPACITY.

(Methods of measuring inductance and capacity, preservation, and calibration of standards of inductance and capacity, design of apparatus involving inductance and capacity phenomena, development of formulas for computing inductance and capacity, measurement of short-time intervals.)

### Inductance and Capacity Laboratory.

With the exception of necessary work in routine testing, this section has devoted practically all its time during this year to military problems. The amount of testing has increased considerably, especially during the latter half of the year.

The development of formulas for the alternating-current resistance and inductance of a "return circuit" has been completed, and the formulas have been applied to experimental results obtained by others, showing good agreement. A paper giving the derivation of the formulas and a discussion of the results has been prepared for publication under the title, "An Integration Method of Deriving the Alternating-Current Resistance and Inductance of Conductors."

Measurements of the resistance and inductance of a "return circuit" composed of No. 2 copper wire have also been made in the laboratory at frequencies of 500, 1,000, 2,000, and 3,000 cycles per second, and the measured values agree very well with those calculated by the formulas.

## Gun-Firing Investigations.

The gun-firing investigations which this section undertook for the Bureau of Ordnance, Navy Department, some time ago have been continued throughout the year, and the scope of the work has been broadened until now it covers a large part of the field of ballistics. A study of the work that has been done by others along similar lines indicates that the section has collected a larger amount of data concerning the behavior of certain types of guns than has been collected heretofore. The chief investigations which are being carried on by the section at the present time are listed below.

*Theoretical Study of the Motion of a Projectile.*—Prof. H. C. Richards of the Physics Department of the University of Pennsylvania spent the summer of 1918 at the Bureau studying the theory of the flight of a rotating projectile. He consulted all available literature and attempted to reconcile the theories with the experimental data available. Dr. Richards has continued his interest in this subject throughout the year and is preparing a report of his work.

*Study of Variations of Gun Pressures with Time.*—Data obtained during the experimental firing on naval vessels indicated the need of a time-pressure gauge. An experimental gauge was designed and built at the Bureau during the summer and fall of 1918. It was tested by placing it in a bomb in which a small charge of powder was exploded. As these experimental tests gave very promising results, the Bureau of Ordnance ordered five gauges made for use in certain of the naval guns. These gauges have been completed and are now being given the final tests at the Bureau. Recently the Ordnance Department of the Army requested the use of these gauges in their work.

*Primer-Explosion Times.*—In the work during the previous year on electric cannon primers it was assumed that the breaking of the platinum bridge wire indicated the explosion of the primer. Subsequent experiments, however, showed that this was not always the case. An additional investigation was, therefore, carried on in which the time of the explosion of the primer was taken as the time at which a fuse wire placed in front of the primer was broken by the flame. A number of makes of primers were used in the investigation. It was noted that the older primers were slower in firing than those of recent manufacture. The Bureau of Ordnance has requested that the investigation be continued, using a large number of primers of as many different " ages " as possible.

*Ejection Velocities.*—In the study of factors which may cause dispersion of fire there is need for a method by which the muzzle velocity of each projectile fired from the ship can be measured. Considerable time during the past year has been spent in the study of this subject, and a method has been developed by which the " ejection velocity " of a projectile may be determined on shipboard with an accuracy of approximately 1 per cent. The velocities so obtained are designated as "ejection velocities," since they differ slightly from those usually defined as "muzzle velocities."

*Study of Recoil.*—Recoilmeters have been built which, in connection with the oscillograph, record the time at which the gun passes certain predetermined points in its recoil and counterrecoil. From these data a space-time recoil curve can be plotted. By successive graphical differentiation of the space-time recoil curve, velocity-time and acceleration-time curves may be obtained. Theoretically these curves should furnish information regarding the velocity of the shell inside the bore of the gun and the variation of powder pressures within the gun chamber. Results so obtained, however, do not agree with those obtained from the theory of internal ballistics and indicate that this theory is not as well known as it should be. The study of the recoil also gives information concerning the forces which the gun mountings must withstand during the recoil of the gun.

*Firing-Time Intervals.*—A study of the firing-time intervals which occur during the firing of the gun has been continued in cooperation with the Navy during the year at Indian Head and aboard ship. The chief items of interest to be noted in this work are that the powder interval—that is, the interval which elapses after the primer explodes and before the gun begins to recoil—varies largely for different shots, and that the barrel time—that is, the time after the beginning of recoil until the ejection of the shell—is a function of the gun and its mounting.

*Jump and Whip of Guns.*—Kinemeters, which have been used in experimental firing, have been constructed for the Navy and measure the jump and whip of a gun at the instant it fires.

*Velocity Inside Bore of Gun.*—During the latter part of the year the Coast Artillery has been cooperating with the Bureau in the design of apparatus for determining the velocity of the shell as it moves through the bore of the gun. This apparatus is now being completed in the shops of the Bureau.

*Velocity Measurements by Means of Magnetic Effect of Projectiles.*—In the past a number of attempts have been made to determine the velocity of a projectile by shooting it through coils of wire and using the current induced in the coil to determine the time at which the shell passed through the coil. In general, these attempts have not been successful on account of a lack of knowledge of the fundamental physical effects which are involved.

At the request of the technical staff of the Army, this Bureau has undertaken an investigation of the possibilities of this method. It is proposed to study particularly the relation between the phase of the induced current and the position of velocity of the shell.

*Blast Investigations.*—Throughout the year the Bureau has continued the measurement of the characteristics of the blast of large guns for the Navy, but since other lines of work have seemed more urgent this work has not progressed as rapidly as was desired. An electromagnetic blast meter has been designed and built, and preliminary tests are being made at the Bureau preparatory to testing it under service conditions at Indian Head Proving Ground.

### Timing Device.

In the study of the method of determining ejection velocities, a special timing device, with which an electrical oscillograph may be equipped, has been developed. Tests of this device show that by its use time intervals may be determined to an accuracy of a few millionths of a second. While the method was developed for a particular purpose, it is applicable to the measurement of any small time interval which it is possible to record electrically.

### Submarine-Mine Investigations.

*Improvement of Mine Detonators.*—At the request of the same bureau, the study of possible improvements in a special type of mine detonator was undertaken late in the year.

*Protection of Ships Against Mines.*—At the request of the Navy Department, one of the representatives of the Bureau, while in England, visited the mine-sweeping fleet to make some experiments on a method which was in use for the electrical protection of the mine sweepers engaged in the removal of the North Sea mine barrage. A satisfactory method of protecting the ships themselves had been devised, and it was desired to extend the method so as to protect the sweep wires also. Difficulties inherent in the method made this extension impracticable.

### Hydraulic Machine-Gun Synchronizing Gear for Airplanes.

At the request of the War Department, a detailed study was made of the factors which are of importance in hydraulic methods of synchronizing machine-gun fire in airplanes. In this work it was shown that there is an appreciable time interval required for the transmission of the energizing pulse in the tube of liquid which is used to fire the gun. The fact that such a time interval is unavoidable in any hydraulic or other mechanical control system limits the application of such devices and is a strong argument for using an electrical system such as that mentioned above, in which the time required for the action of the control gun itself can be made very small.

### Special Muzzle-Velocity Measurements.

At the request of the Army, measurements were made of the velocity of bullets fired by centrifugal guns which were under test at the Bureau. The measured velocity agreed quite closely with the theoretical velocity. Measurements were also made of the muzzle velocity of a captured German automatic antiaircraft gun of 2-centimeter bore, using regular German service ammunition.

### Study of Recent Scientific Developments in France and England.

The chief of the section spent April, May, and June, 1919, in France and England studying scientific developments which have occurred during the war, especially the improvements in ballistic instruments. Both the Army and the Navy cooperated heartily; they extended every courtesy and in many ways showed their appreciation of the studies which were being undertaken. All of the important scientific laboratories doing research work along ballistic lines were vistited. In addition many observations of general scientific interest were made. A report covering this trip is in preparation.

## ELECTRICAL MEASURING INSTRUMENTS.

**(Testing and development of electrical instruments, meters, and ignition apparatus.)**

### Testing of Electrical Instruments.

The volume of testing for outside parties was very much reduced by the war, but the testing for Government departments was greatly increased, so that the total number of instruments tested was larger than in previous years.

The testing of instrument transformers had to be discontinued during the war because of the departure from the Bureau of members of the staff who had previously been engaged in this work. This class of testing has been resumed in the last few months. The accurate testing of these transformers is of increasing importance on account of their use in measuring electrical energy, especially where it is sold in large quantities or at high voltages and the Bureau has consequently given special attention to the development of methods and equipment for testing them.

### Electrical Tests of Gasoline-Engine Ignition Systems.

The demand for routine tests of ignition apparatus reached a maximum last autumn and has since decreased, but requests for tests are still being received from manufacturers at the rate of about four per month.

The investigational work on spark plugs as first planned has been completed except for measurements of temperature conditions in aircraft engines. This latter work has been held up for lack of both staff and available engines. The porcelain developed by the Bureau is now in regular production by the largest spark plug manufacturer in the country.

The use of a subsidiary gap in series with a spark plug was studied experimentally, and a preliminary report has been issued showing the advantages and disadvantages of this device.

Considerable study, both theoretical and experimental, has been made of the operation of the high-tension magneto with a view to developing a working theory on which to base a logical design of such apparatus. Particular attention is being paid to the effect of secondary capacity and eddy currents, and methods are being developed to measure these effects quantitatively.

A series of 15 reports have been issued covering various phases of the ignition work. These reports will be printed in the Fourth Annual Report of the National Advisory Committee for Aeronautics.

At the request of the Motor Transport Corps specifications for spark plugs have been prepared to serve as a basis for their purchase.

Considerable time has been spent in cooperation with the areonautic engine-design section in developing a method for measuring the velocity of flame propagation in the cylinders of internal-combustion engines. This method, which records the time of passage of the flame oscillographically, gives good promise of success and an extensive program of work has been laid out for it.

### Electrical Trucks and Tractors.

At the request of the War Department, the Bureau cooperated in comparative tests of a large variety of electrical trucks and tractors for use in Army warehouses. The records of these tests were worked up and reports issued by the Bureau on the basis of which the Purchase, Storage, and Traffic Division has prepared specifications for the purchase of such equipment.

### Turret Fire-Control Apparatus.

A study of the electrical target turret indicators used in controlling the fire of battleship turret guns was begun last year in an attempt to find the causes of errors which sometimes occurred in the indication of the apparatus. This investigation was continued this year, and after a thorough study of the operation of the apparatus at various speeds, changes in the equipment, which it was believed would remedy the defects, were suggested to the Navy Department and to the makers of the apparatus.

### Blasting Caps.

At the request of the Engineer Corps, a study was made of the time required to fire electrical blasting caps used in setting off mines, gas projectiles, etc., with a view to determining the possibilities of firing a number of such caps in series. About one hundred caps were fired under various conditions and the time recorded by the oscillograph.

The study of blasting machines mentioned in last year's report has led to the development of a new type of machine having over 10 times the capacity of the older type and slightly less cost and weight.

### Radio Generators.

Considerable time was spent in planning and supervising tests of 900-cycle generators for use in airplane radio sets. The work consisted in obtaining characteristic curves, efficiencies, etc., of a number of generators under various conditions. The observations were made by enlisted men of the Signal Corps, but the planning of the work and preparation of reports was under the direction of the Bureau.

### Cooperation with American Institute of Electrical Engineers.

At the request of the Instruments and Measurements Committee of the American Institute of Electrical Engineers, the preparation of an exhaustive paper on "The accuracy of Commercial Electrical Measurements" has been undertaken. This work is well under way, and the paper will probably be delivered at the institute meeting in the autumn. A considerable amount of time has also been given to assisting in the revision of the American Institute of Electrical Engineers Standardization Rules, and many errors and inconsistencies in the older edition have been eliminated.

### New Apparatus for Electrical Instrument Testing.

An attachment is being developed for use with the deflection potentiometer which serves to plot automatically the corrections of the instrument under test, thus avoiding all numerical computations. When a set of standard shunts designed to accompany this has been built, the time required in instrument testing will be materially reduced.

A new form of variable resistence has been constructed for use in testing current transformers and is now ready for final adjustment.

The use of this will reduce the labor of such tests by at least 30 per cent.

### Ignition of Cotton by Electric Sparks.

At the request of the Department of Agriculture some experiments were made on the ignition of cotton by electric sparks and on the generation of electrostatic charge by the passage of cotton through iron tubes. This request was occasioned by the frequent fires which occur in cotton gins apparently as a result of static discharges. The results obtained indicate that this is a very real fire hazard and that the fire risk in gins can be materially reduced by proper electrical grounding of the metal parts of the machinery.

## MAGNETIC MEASUREMENTS.

(Measurement of magnetic properties of materials; design and calibration of magnetic instruments and appliances, including compasses; magnetic analysis.)

### General Magnetic Measurements.

In addition to the routine testing of the magnetic properties of materials, the work of the section includes the experimental study of various methods and instruments for making magnetic measurements. Such a study is nearly completed on a new type of permeameter (the Fahy Simplex), which has recently been put upon the market. The results so far obtained indicate that the instrument is convenient and rapid and has an accuracy which is satisfactory for most commercial and research purposes. The instrument requires only a single specimen, and there are no compensating adjustments to make.

### Magnetic Analysis.

For a number of years work has been under way at the Bureau in the development of methods and apparatus for using the magnetic properties of materials as an indication of their quality and mechanical properties. The results of this work and the growing interest of manufacturers of steel products justify a systematic general study of the subject for the purpose of determining to what extent magnetic analysis can be utilized both in research and for practical testing on a commercial basis. The method promises to be very useful for the detection of inhomogeneities and flaws, for the detection and study of physical and chemical transformations which take place in iron or steel on heating or cooling, and for the estimation of the physical condition and the prediction of mechanical behavior of steel and steel products.

During the past year a comprehensive program has been started which consists of three distinct though closely interrelated parts:

I. Study of the fundamental relationships between the magnetic properties and the physical structure and mechanical properties of various types of steel by means of accurate magnetic and mechanical tests on specially prepared samples.

II. Development of special apparatus and methods for making magnetic tests on various forms of steel objects.

III. Development of a number of direct practical applications for the purpose of demonstration.

In this work the magnetic section has the cooperation of a number of commercial organizations as well as of other sections of the Bureau.

*Rifle-Barrel Steel.*—An investigation has been completed and a paper is in press on "The Testing of Rifle-Barrel Steel for the Detection of Flaws." This investigation was made in cooperation with a large manufacturer of rifles. The results of the work indicate that the magnetic method will surely detect flaws, but that other causes may render the material nonhomogeneous along its length when it is not necessarily unfit for use. In view of this fact it seemed desirable to study further the possibilities and limitations of the magnetic method, and in this work the Bureau has the valuable cooperation of the Technical Staff of the Ordnance Department. The construction of special apparatus for this investigation is under way.

*Ball-Bearing Races.*—The development of a magnetic method for the testing of ball-bearing races which was interrupted during the war has been resumed in cooperation with one of the large manufacturers of ball bearings. It is proposed, if possible, to develop a method which will be commercially practicable for the determination of hardness and the detection of cracks or soft spots.

*Correlation of Properties.*—An investigation has been started for the correlation of the magnetic properties with the micrographic structure and mechanical properties of a carbon steel of eutectoid composition. Accurate tests will be made on standard test pieces after various heat treatments. Information of this kind is fundamental to the development of magnetic analysis and the investigation will be extended to include the study of various types of steel.

*Miscellaneous Problems.*—In addition to the above investigations a number of less-extended experiments have been made to ascertain the applicability of magnetic analysis for the inspection of various articles, including welded ship plates, airplane tie wire, and rifle-barrel forgings. Most of this work was not completed owing to the fact that with the ending of the war the necessary funds and facilities were no longer available.

### Magnetic Compasses.

Most of the work on magnetic compasses during the year consisted of cooperation with various branches of the military service. In addition to work on testing of airplane compasses, which consisted of testing a small number of instruments for the purpose of checking the field inspection, a number of special investigations were made covering various points of compass construction. These investigations included the development of a suitable process for aging compass magnets and a test for aging, a study of the relative merits of platinum and stellite for pivots, and a study of the relative behavior of natural and artificial jewels for pocket compasses.

A collection of a number of types of airplane compasses which will be valuable for further study has been made.

## PHOTOMETRY AND ILLUMINATING ENGINEERING.

**(Maintenance of photometric standards, calibration of standard lamps, development of methods of photometry, inspection and life test of electric lamps, problems in the utilization of light.)**

### Military Searchlight Investigations.

On account of the importance of searchlights in modern warfare and the need of more knowledge of their characteristics and performance, the Searchlight Engineering Section of the Four Hundred and Eighty-eighth Engineers requested the Bureau to cooperate with them in the investigation and testing of searchlights. The work was begun in March, 1918, and continued until January, 1919. The investigations included the following:

*Distribution of Light from the Bare Arcs.*—Light distribution in several planes through the arcs without mirrors was measured in the laboratory. Seventeen arcs of various types and conditions were measured in this manner. From these measurements information was obtained as to their effectiveness in various searchlight mechanisms. The tests were also useful in giving data for specifications for searchlight carbons.

*Distribution of Light in the Searchlight Beam at Various Distances.*—A great many tests were made to determine the distribution of illumination in the beam. The most of the tests were made at a distance of 930 feet, 20 lamps being so measured. In addition, other measurements were made at various distances up to 5 miles.

*Absorption of Light by Front Glass of the Searchlight.*—A number of tests were made to determine the amount of light lost by absorption, reflection, and scattering of light by the front glass, and by devices for limiting the beam and avoiding stray light.

### Photometric and Illumination Investigations for Military Departments.

*Daylight Signaling Devices and Special Lamps.*—A great deal of time was spent in a study of daylight signaling lamps and lamps for signaling from airplanes at night, this work being undertaken at the request of the Bureau of Aircraft Production. Daylight signaling tests were carried out over ranges of one-half, 2, 3 and 5 miles to determine the magnitude of the intensities required. Many tests were also made to determine the increase in beam efficiency due to partial silvering of lamp bulbs used in the signaling devices.

*Protective-Fence Lighting.*—In September, 1918, the Bureau was requested to make a comparative test of various floodlight projectors for protective-fence lighting. The tests were carried out with the cooperation of the Ordnance Department and resulted in the recommendation of the use of angle reflectors throwing the light at right angles to the fence instead of floodlights throwing the light parallel to the fence, as the tests showed that the smaller reflectors were superior to floodlights for the type of service required. The signing of the armistice stopped purchases of such equipment, but the results of this investigation will be of assistance in the future design of protective lighting installations.

*Acetylene Generators.*—Last year several months were spent in an investigation of the performance of numerous types of portable acetylene lights, with particular reference to their suitability for military use at the front. This investigation was originally intended simply to give information on which a choice between the various types of lights could be based, but it developed that many of them had certain features which made them unsuitable for use under the prescribed conditions. Consequently the makers were consulted, and a number of modifications suggested by the Bureau were made in the lights.

During the present year, as a result of a controversy over the merits of one of the lights recommended as a result of the above investigation in comparison with a new type developed for Army use, further investigation was requested, and extensive tests were carried out, particularly to determine the reliability of operation of the lights. The results obtained fully confirmed the earlier recommendations of the Bureau.

*Miscellaneous Tests.*—In addition to the special investigations outlined above, numerous acceptance tests of kerosene and signal oils, reflectors, luminous flares, star shells, etc., were made. To assist military departments in the design of instruments and apparatus many lamps were photometered and illumination instruments calibrated.

### Standardization of Screens for Measurement of Brightness of Radioactive Materials.

The measurement of the absolute brightness of radioactive, self-luminous materials has become commercially important because of the greatly increased use of such materials in recent years. This work is handled by another section (see report below) but the photometry section has been called on for the calibration of colored screens which are used to make the light from electric lamps comparable in color and intensity with the luminous materials. Such screens have been standardized for the Bureau of Mines as well as for this Bureau.

### Inspection and Life Tests of Incandescent Lamps.

Orders for about 4,225,000 incandescent electric lamps were placed by departments of the Government during the year. Of this quantity about 75 per cent were large tungsten, 13 per cent carbon, and 12 per cent miniature lamps. Six per cent of this total were ordered shipped without inspection, whereas during the previous year about 20 per cent were so ordered from a quantity approximately twice as great. Actual inspections by this Bureau during the year, including lamps delivered on orders last year, approximated 5,100,000, of which about 4,000,000 were large tungsten, and the remainder carbon and miniature lamps in about equal quantities. This represents an increase of about 40 per cent in inspection over last year.

The initial inspection made at the factories covers the mechanical qualities of the lamps and their rating with regard to power consumption and efficiency. In order to pass a final judgment on the quality of the lamps it is necessary to have actual burning tests, and when the initial inspection is made samples are selected for such tests, which are called "life tests." During the year life tests were completed on 2,683 vacuum tungsten, 152 gas-filled, and 373 carbon lamps. Records of these tests were kept separate for each month of manufacture in order to compare results with those obtained in current tests of the product made at the factories. It was found that gas-filled lamps, which are now included in the standard specifications, considerably exceeded the life requirement, and, following the usual practice, one of the large manufacturers has improved efficiencies to take up a great part of this excess life. Efficiencies of vacuum tungsten lamps are also undergoing a gradual improvement.

Work of considerable importance was done by special inspections and tests of lamps for the General Supply Committee in connection with bids for supplying lamps under contract for the fiscal year 1920; data regarding the quality of lamps which some of the new bidders proposed to furnish were obtained as a result of these tests, and served to guide the Supply Committee in placing the new contracts.

While the specifications for large lamps are in a very satisfactory form, and the efficiency and performance of these lamps are well established, there is little available information with regard to the general commercial quality of miniature lamps such as are used in flashlights and in automobile and similar lighting equipment. As a part of the standardization work in which the Bureau assisted the War Department during the year, tentative specifications for some types of miniature lamps were drawn up and agreed upon with representatives of the manufacturers, but on account of the lack of information as to the limits which could reasonably be fixed for efficiency and life of such lamps the specifications could not be made very strict. Apparatus for making life tests of miniature lamps has now been designed, and the component parts have been purchased. It is expected that this equipment will be installed in time to carry on regular tests on the lamps bought on Government contract during the coming year.

### Illumination Surveys of Commerce Department Buildings.

At the request of the Secretary of Commerce an illumination survey of the main building of the Department of Commerce was made. The average illumination in the offices was found to be about 2.5 foot-candles, which is considered the lowest allowable intensity for office work. It was shown that the existing level of illumination could be maintained by substituting more efficient lamps of a lower wattage, making the connected load 30 per cent less, or that the substitution of more efficient lamps of equal wattage would make the intensity about 4 foot-candles, a value more in conformity with good practice.

Some surveys were made in the Coast and Geodetic Survey building and advice given for the material improvement of the lighting in certain special cases. Pressure of other work has prevented a complete analysis of the lighting of all Commerce Department buildings, although preliminary inspection shows that there is room for improvement in several of them.

## RADIO COMMUNICATION.

(Maintenance of standards and development of methods of measurement at radio frequencies; investigation, standardization, and improvement of instruments and methods of radio communication; investigation of the properties and uses of vacuum tubes.)

### Development of Radio Work of Bureau.

There has been a great expansion of the work of the radio section during this year. The section moved into its new building in October. This change was made the occasion of increasing the equipment and establishing permanent set-ups for testing and for other work involving measurements of a more or less routine nature. The research program has been largely prepared with a view to cooperation with the Signal Corps and Navy Department. For the period of January to June of this year the investigations have been almost entirely work that was undertaken for the Signal Corps.

During the summer of 1918 the section was fortunate in obtaining the services of a number of men of special qualifications from various universities and technical schools who assisted most effectively, particularly in the preparation of the radio textbook mentioned below. For special work of other kinds the section had the advantage of the services of a number of soldiers detailed by the War Department, assisting particularly in the work on vacuum tubes, oscillographic measurements, and testing.

The work of the section is developing into the general field of electrical communication. The methods and instruments of high and low frequency communication are coming to have much in common, and the future promises much in the way of the utilization of the intermediate frequencies which have hitherto been little used. This development is largely due to the vacuum tube and the general study of high-frequency measurements.

**Electron Tubes.**

An investigation of three-electrode vacuum tubes or electron tubes has been undertaken on a considerable scale. The first work in this field was vacuum-tube standardization for the Signal Corps. Later a number of specific problems in this field were undertaken for the Signal Corps and the Navy. The work has been furthered by conferences held at the Navy Department between the Government departments concerned and the manufacturers of the tubes.

Apparatus and methods have been developed to determine the principal constants and to study the uses of electron tubes as generators, detectors, amplifiers, and modulators. The principles involved in the functioning of these tubes have been studied; for example, one piece of work has been a theoretical study, verified by experiment, of the calculation of the constants of tubes from their dimensions. A critical study has been made of the Signal Corps testing sets for measurements upon electron tubes, and improvements in the sets have been suggested.

Special study has been given to the subject of tubes for generating alternating currents, commonly called "power" tubes. The investigation has had the very satisfactory result of developing a method for calculating the power output from the characteristics of the tubes. This investigation also included a study of the harmonics in power-tube circuits, in typical cases. The dependence of the harmonics on the resistance and reactance of the high-frequency circuit has been determined, and means of calculating the harmonics of the high-frequency current from the form of the pulsating-plate current have been devised. The use of large power tubes has been studied, one of the principal problems being the development of a source of the direct voltage needed for supplying power to the tubes. The use of the large tubes as amplifiers has also been studied. This work has direct applications to the development of practical systems of radiotelephony.

The detector action of electron tubes has been made the subject of a special research. Methods and apparatus for measurement of the detector action have been developed. The detector sensitivity of typical tubes has been measured under varying conditions, and the theory of detector action has been worked out.

A considerable contribution to the fundamental design of amplifiers was made in an investigation of the input impedance of electron tubes. The Signal Corps had found in practice that the constants of the output or plate circuit of a tube affect the apparent input impedance. This complicated the design of amplifiers in which tubes fed successively into one another, and, in fact, made the prediction of performance of any given amplifier circuit practically impossible. The solution to this problem of the effect of the constants in the output circuit on the input impedance was worked out theoretically, and a very satisfactory experimental verification was obtained. This work greatly facilitates the design of amplifiers and gives a better understanding of the operation of electron tubes.

### Coil Aerials.

Experiments have been continued on the development of the coil as an aerial in place of the ordinary antenna. Methods of measuring received current were devised and experiments made to check transmission formulas and to assist in determining the fundamentals of design of such coils. A detailed study was made of the resistance of coils and methods of measurement thereof, and the results of measurements of resistance and other constants were coordinated with the results of transmission experiments. These experiments were made on coils of varying dimensions, numbers of turns, etc.

A general paper was prepared on the principles of this subject, discussing the nature of electric waves and radio transmission and reception, giving transmission formulas for either antenna or coil aerials, and discussing the fundamental principles of design and measurement of the antenna effect in coil aerials and of radiation resistance.

A study was made of the accuracy of determination of direction with a direction finder as affected by various kinds of objects in the vicinity. With nonmetallic bodies, such as a tree, a brook, or a bank of earth, the distortion or change in observed direction became negligible at a distance equal to the largest dimension of the object. With objects constructed in whole or in part of metal, such as a bridge, water tower, or the Washington Monument, the distortions were very large and changed greatly with wave length. It was concluded from the experiments that a direction finder must be kept at least 300 feet away from such objects.

An apparatus for determining the absolute direction, as well as line of direction of a radio wave, was developed. The device utilizes the capacity of the coil structure to ground, an inductance in series with this capacity being tuned to the same frequency as the coil circuit. Field experiments showed that the device determines absolute direction satisfactorily. It is, however, somewhat difficult to use, since, like other similar methods which have been developed for unidirectional observations, it requires sensitive adjustments.

### Signaling System for Airplane Landing.

Experiments originally requested by the Air Mail Service of the Post Office Department have been in progress to develop a method to enable an airplane to find its landing place in fog or in the dark. The Signal Corps has recently taken an interest in this problem, and the method may be of use for Signal Corps purposes. The object in view has been attained by two general methods. In both a large coil is wound on the landing field and a receiving coil is placed on the wings of the airplane. In one method low-frequency current of 500 or 1,000 cycles per second is passed through the coil. In the other radio-frequency current is used in the coil. By these methods it has been possible to receive signals with an airplane 6,000 feet in the air. The system has the desired characteristic that the signal falls off rapidly as the landing field is left. The transmitting coils used have varied from a size 80 by 200 feet to a size 1,400 by 2,500 feet. A large amount of experimentation has been necessary to determine the proper constants of the transmitting and receiving systems and to determine the characteristics of the method at the various frequencies tried.

### Submarine Radio Communication.

Satisfactory methods for communicating with submerged submarines have been urgently needed, and two members of the Bureau staff spent several months during the summer of 1918 at the New London submarine base developing the application of coil aerials for this purpose. Very satisfactory results were obtained. With a single-turn coil or loop attached to the outside of the submarine, signals could be received as well when the submarine was submerged as when on the surface. It was also possible to transmit from a submerged submarine a distance of 12 miles. It thus becomes possible for a ship and submarine to exchange recognition signals. A coil aerial is a satisfactory direction finder when submerged and readily receives signals transmitted thousands of miles just the same as when used in air. The Navy Department considers this the best work which has been done on submarine radio and has equipped the larger submarines with the apparatus which was developed by the Bureau's experimenters.

### Insulating Materials.

The investigation of insulating materials carried on this year has been limited mainly to the laminated materials of the phenol or bakelite type, such as are used extensively in making electrical, and particularly radio, apparatus. The electrical properties measured are power loss and dielectric constant at radio frequencies, flash-over voltage and volume, and surface resistivity. The tests of mechanical properties which were made in other sections of the Bureau and for which the samples were cut and the work given general supervision by this section included tensile and transverse strength, hardness, brittleness, permanent distortion, thermal expansivity, density, and moisture absorption. Methods of measuring the effects of high voltages at radio frequencies on the materials were developed. The methods of measuring power loss or phase difference at radio frequencies were improved and a cabinet generating set especially adapted to this work was constructed. Minor improvements were made in the methods of measurement of various properties. The results of measurements indicate, in general, that these materials are susceptible of improvements and that the product of a particular manufacturer varies more from time to time than the products of the several manufacturers differ from one another. The manufacturers and some of the users of these materials have shown an unusual interest in the investigation, and there is every prospect that this investigation will constitute an interesting line of research for some time to come.

## Radio Measurements.

High-frequency oscillographic equipment has been developed. Three cathode-ray tubes were constructed and the auxiliary pumps, ovens, etc., provided. One of the tubes is of the hot-cathode type, having movable electrodes, so that a most efficient design can be determined. The equipment has been applied to demonstrations of the steadiness of vacuum-tube generators, to the testing of quenched gap transmitters, and to research on generating vacuum tubes.

A study was made of the production, measurement, and utilization of high voltage and large current at radio frequencies. A vacuum-tube equipment, consisting of six large power tubes, was developed for this purpose. A voltage of 48,000 volts at radio frequencies may be applied to samples of insulating material, and currents of 100 amperes at radio frequencies may be produced for the testing of ammeters. A study has been made of the measurement of radio frequency resistance. A variable resistor for radio frequencies was developed, a study of the precision of measurement made, and sources of error investigated. The study of resistance measurement at radio frequencies is particularly important, since such measurement gives the means of determining a number of quantities, as, for instance, wave form and power.

An investigation was made to determine whether a crystal detector could be developed having a permanent contact. The methods tried in the effort to secure a sensitive, permanent contact detector included alternating-current electrolysis, cathode sputtering, direct-current electrolysis, soldering, arcing, spark welding, and mechanically maintained contact. The latter method gave a thoroughly satisfactory detector, but the general conclusion of the investigation was that the sensitiveness of the best crystal detectors depends upon the existence of an imperfect contact.

The use of a grounded shield in connection with measuring circuits was developed. There has heretofore been no method of protecting the complete radio circuit from troublesome stray electromotive forces, in the way that, for instance, a condenser is protected by its shield. It was found that a shield in the form of a grid of wires between the generating and measuring circuits improved the steadiness of the deflection and the precision of measurement a very great deal. A shielded cage for the inductance coil of the measuring circuit was also developed, so that the entire circuit can be thoroughly shielded.

## Radio Textbook.

One of the principal accomplishments of the year was the production of a general textbook to be used in training engineers and operators in the fundamental principles of radio communication. The publication of Circular 74, "Radio Instruments and Measurements," and the furnishing by the Bureau of additional material for use in instruction work led the Signal Corps to request the Bureau to prepare a general textbook of radio communication for the training of radio electricians in the Student Army Training Corps and in the field signal battalions. By the concentrated effort of several members of the staff, ably assisted by a number of specially qualified teachers from various schools, the book was prepared in three months. It has been printed as radio Pamphlet No. 40, of the Signal Corps, with the title, "The Principles Underlying Radio Communication," and has been most favorably received as being simple, intelligible, and nonmathematical, although giving an accurate and fairly complete discussion of the fundamentals of radio work.

## SOUND RANGING.

(In normal times the staff of this section is engaged in the study of electrolysis and related problems. During the war nearly all of the staff of the section were assigned to various military problems, especially sound ranging.)

During the year 1917–18 a large amount of time was given to the study of methods of locating hostile batteries by recording electrically the times at which the sound of a discharge reached a number of stations. After comparing the merits of various systems in use, the Bureau undertook to improve the equipment of one type used by the French Army, which appeared most promising. As stated in last year's report, the equipment developed at the Bureau was sent abroad for trial at the front under the direction of two members of the staff who were commissioned for this work, but the plans for this trial were defeated by the death of the senior officer, Capt. Ernest Weibel, from injuries received while on duty at the front.

On the basis of such information as could be obtained from the front and from field tests at the Winthrop Proving Ground, the development of the equipment was pushed actively until the final apparatus was believed to be definitely superior to any other equipment in use. Besides other advantages, the Bureau's equipment was capable of being made up in mobile sets, and thus promised to be especially valuable in the type of warfare which developed during 1918. Sets were sent to France and to Italy, and two more members of the staff had just gone over to put them into operation when hostilities came to a close.

At the request of the War Department, work was continued for some weeks after the armistice was signed, in order to complete the sets then under way, and it is understood that when the reorganization of the Army is completed the cooperation of the Bureau will again be desired in developing a standard type of sound-ranging equipment.

## ELECTROCHEMISTRY.

(Electrochemical problems, particularly those involved in the study of electric batteries, electrical properties of chemical compounds, the silver voltameter, and other investigations in electrical measurements.)

### Dry Cells.

The circular on dry cells mentioned in the report of last year was completed and published as Circular No. 79. It describes the various sizes and kinds of dry cells, the electrochemical principles involved, and the service which may be expected from dry cells of various sizes. As an appendix to this circular, specifications for dry cells are given which were written at the Bureau and have been formally adopted by the War Department.

A large number of tests have been made for the military departments. The Signal Corps requested an investigation of small batteries for use with radio amplifiers because of the poor service which they had been giving. Six hundred and sixty-four of the batteries of the type Ba–2 were tested at the Bureau, and nearly 2,000 in the military storehouses. In addition, over 400 of the type Ba–5, which is similar in size but arranged for the addition of water at the time the battery is required for use, were submitted for test. The causes of failure of the cells were determined and methods of improving the service were indicated. A larger type of battery for the same purpose was adopted by the Navy Department in accordance with suggestions made by the Bureau, and this type has also been tested in large numbers. Several tests of batteries for use with a trench-signal projector were made for the Bureau of Aircraft Production, and a considerable amount of material for the manufacture of dry cells, intended for shipment to French factories and the overseas plant of the Signal Corps, was analyzed and tested. Samples of batteries intended for use in submarine mines were tested for the Navy Department and an examination was made of dry cells taken from a captured German mine.

The tests of dry cells for the military departments have been special tests in most cases. For the regular commercial testing of dry cells apparatus to control the tests automatically was deemed desirable, since the cells have to be subjected to alternate periods of discharge and recuperation, and for this purpose a control mechanism has been designed and constructed in the Bureau's instrument shop. This apparatus is believed to be superior to any which has previously been used, since one relatively simple piece of apparatus is capable of controlling a number of different tests at the same time, while the equipment which has been in use at various manufacturing plants is generally complicated and can make only a single test. The work of installing this apparatus was begun at the close of the fiscal year.

A large amount of work has been done in studying methods for dry-cell analysis. This involved a comparison of all the available methods for determining the various constituents of dry cells and the selection of those best adapted to battery problems. The methods which were selected have been prepared in the form of a manual that can be put in the hands of a routine worker.

The tests which were made for the military departments showed the need of systematic study of the causes of deterioration of dry cells when not in use and of means for obtaining a satisfactory "shelf life" of cells. This was undertaken during the latter part of the fiscal year. The following lines are considered the most important parts of this research: (1) Measurements of the conductivity of powdered manganese-dioxide ores with reference to the size of the particle and the intercomparison of ores from various sources; (2) the corrosion of zinc by electrolytes containing various concentrations of ammonium chloride and zinc chloride; (3) the potentials of the manganese-dioxide electrode in solutions of varying hydrogen-ion concentrations; (4) the measurement of the hydrogen-ion concentration in various dry cells; (5) the making of limited numbers of dry cells at the Bureau from materials of which the chemical and physical properties have been studied. Much of this research is made necessary by changes in sources of supplies obtainable by the manufacturers which have resulted from the war.

At the request of the Signal Corps, an investigation of the galvanic pile was begun to determine the possibilities of its use where only small currents are required. The Bureau developed a disk cell, containing the ingredients of a dry cell, which compared favorably with the type Ba–5 batteries and avoided the principal source of failure which was found in them. Investigation has also been made of galvanic piles in the form of zinc-copper and zinc-carbon couples.

In connection with the efforts of the Food Administration to conserve foodstuffs the Bureau was asked to render a report on the use of wheat flour in the manufacture of dry cells. It was recommended that the manufacturers be permitted to use wheat flour unfit for human consumption, and this recommendation was acceptable to both parties.

### Storage Batteries.

An extended test of storage batteries for the propulsion of electric trucks and tractors was made for the Construction Division of the Army. Measurements of the capacity and efficiency under various conditions were made on batteries submitted by all the principal manufacturers, and the speed and acceleration of an electric tractor when equipped with batteries of the lead-acid and of the iron-alkali types were determined under service conditions. After the report on this test was submitted to the War Department, the Bureau was requested to continue the investigation to obtain additional information needed in the preparation of adequate specifications for tractor batteries. An extended series of measurements was made on the more important types of batteries, and the Bureau assisted in the preparation of preliminary specifications.

A test of the drying of wood separators in batteries shipped and stored without electrolyte was made for the Motor Transport Corps.

A number of extended tests, involving the analysis of acid and alkaline electrolytes for storage batteries, were made for the Signal Corps and the Panama Canal. These tests involved an extended study of the methods available for the analysis of battery acid, particularly with reference to the determination of nitrates and nitrites and other impurities which, if present even in small amounts, have a deleterious effect on the storage battery. The methods of analysis which were found best suited to the battery problems have been prepared in the form of a manual. Considerable research was also necessary for the analysis of the alkaline electrolytes, this being a more unusual problem than that of the acid analysis. The Bureau has collected from manufacturers and large users of storage batteries the specifications for battery acid and finds that the amounts of certain impurities permitted by these specifications vary by 1,000 per cent. As no reliable information is available on the effects of many impurities which are often present in battery acid, a series of experiments to determine these effects was begun and carried on during the year.

Methods for measuring the single potentials of the plates in storage cells have been studied, since this is a valuable method of testing the batteries. It has involved a comparison of a number of different half-cell electrodes and a series of experiments on the cadmium electrode which has been used in a limited way for many years. In this work the errors to which the cadmium electrode is subject were determined, and it was found that by a slight change in the ordinary procedure the more serious of these errors could be eliminated. A series of questions sent to the different manufacturers and a search of the literature on the subject shows that no reliable information as to the use of this electrode and the errors to which it is subject has been available in the past.

The Construction Division of the Army undertook the preparation of a manual on tractor batteries for use in maintenance stations. Fundamental data for this manual were obtained at the Bureau during the tests which had been in progress. At the close of the fiscal year, the Construction Division requested the Bureau to assist in the completion and publication of this manual, and it is to be published by the Bureau as a circular.

The War Department Committee on Education and Special Training also undertook the preparation of a manual consisting of job sheets for the instruction of the enlisted personnel and reserve officers in the operation and repair of storage batteries, and this Bureau was requested to furnish information and to criticize the manuscript.

### Railway-Signal Batteries.

During the winter a comparative test of different kinds of railway-signal batteries was made, a number of them being subjected to outdoor weather conditions. It was found that the performance of some makes of these batteries varied greatly with the temperature, and that the usual specifications for test do not make proper allowance for this variation.

## RADIOACTIVITY AND X-RAY MEASUREMENTS.

**(Methods of measurement of radioactive materials and phenomena, standardization and measurement of radium, mesothorium, radium preparations, and similar materials; study and measurement of self-luminous materials; study and standardization of X-ray apparatus and supplies, and the application of X rays to various investigations.)**

### Luminous Materials.

Self-luminous materials contain a small percentage of a radioactive material, usually radium, and require no previous exposure to light to excite their luminescence. This property is of great value in many fields, both military and civil. These materials are used for the illumination of airplane dials of all kinds, of bomb sights, compasses of all kinds, gun sights, round counters for machine-gun magazines, targets for indirect fire, dials for navigation instruments, etc. In civil life they are used for the illumination of dials for clocks and watches, for marking push buttons, pull sockets, signs in dark places; in fact, wherever a faint and entirely self-contained illumination is desired.

When the Bureau began the study of these materials in 1916 but little was known and nothing had been published concerning their properties. In particular nothing was known regarding the effective life of the material and but little data was available regarding the brightness that is needed for various purposes. Both are of prime importance in the practical use of these materials. After developing suitable methods for measurement it was to these problems that the Bureau directed its attention.

A considerable amount of data had been obtained by the time the United States declared war with Germany. This was at once placed at the disposal of the Departments of War and Navy, and from that time to the present the study of problems of special interest to these departments has largely supplanted the more orderly investigation of the initial problems. Material bearing upon the latter has, however, been accumulated throughout this time and will be collated with the earlier observations.

During the year cordial cooperation with the various branches of the military departments of the Government has been continued. This has included (1) the furnishing of information concerning the properties of luminous materials and methods for measuring their surface brightness, (2) recommendations regarding specifications and estimates of cost, (3) the measurement of the brightness of selected articles, (4) the preparation and standardization of apparatus and supplies for the factory inspection of dials, (5) the detailed study of selected specimens, (6) the carrying out of miscellaneous experiments, and (7) the preparation of models of articles so designed that the brightness can be varied, by which much useful information regarding the most desirable brightness is obtained.

Among those with whom the Bureau has so cooperated may be mentioned the several divisions of the Bureau of Aircraft Production and of the Ordnance Department, the Engineer Corps, and the Inventions Section, General Staff, Army; the Bureau of Steam Engineering, the New York Navy Yard, and the Bureau of Lighthouses.

Cordial relations with the manufacturers and civilian users of these materials have been maintained. Many requests have been received from the latter for information and advice. These requests have been complied with as fully as possible, but many pertinent and important questions concerning these materials are still unanswered, and can be answered only by the careful work of an authoritative institution, such as this Bureau, that is able to carry on the work over a term of years.

In addition to investigations of various kinds, routine tests of 418 luminous military articles and of 73 civilian articles were made. One mimeographed circular was issued under the title, "Luminous Material Circular No. RLC-6"; it contained information bearing upon specifications for the illumination of articles, and in a slightly modified form will be published by the National Advisory Committee for Aeronautics under the title, "On Self-Luminous Materials."

### Standard Radium Solution.

Radium solution of known strength was furnished to the Walter Reed Hospital for medical use.

The public was furnished with 100 cubic centimeters of a dilute solution of certified concentration; such solutions are used for the preparation of standards of radium emanation. These standards are necessary for the determination of the radium content of ores, waters, etc., materials containing only a relatively small amount of radium or of radium emanation.

### Radium-Emanation Work.

When a material contains but a small amount of radium, its radium content is determined from the rate at which it produces radium emanation. The latter is a radioactive gas produced by the spontaneous disintegration of radium.

Radium determinations by the emanation method have been made for the Walter Reed Hospital and for the Bureau of Aircraft Production.

## Gamma-Ray Measurements of Radium.

During the first half of 1918 the rate of receipt of radium for measurement and certification was low. Since July, 1918, it has increased rapidly.. Until January most of the material was for export and was intended for military use. Since January the rate of receipt for certification of radium intended for use in surgery and dermatology has far exceeded all past experience of the Bureau.

During the year 474 preparations containing a total of 13,159 milligrams, and of a market value of over $1,500,000, were measured and certified. Of this, 170 specimens, containing a total of 5,065 milligrams, were certified for export, 4,000 milligrams being intended for military use. The preparations for export were distributed as follows:

| Country. | Number. | Milligrams of radium. | Country. | Number. | Milligrams of radium. |
|---|---|---|---|---|---|
| England | 17 | 2,347.9 | Spain | 5 | 67.9 |
| France | 92 | 1,716.3 | Australia | 6 | 27.4 |
| Japan | 29 | 673.5 | South Africa | 1 | 14.7 |
| Brazil | 15 | 130.6 | Argentine Republic | 1 | 11.4 |
| New Zealand | 3 | 70.2 | Canada | 1 | 5.3 |

Since the initiation of its radium work the Bureau has year by year certified radium for export, as shown in the following table, the ratio of the amount certified for export to the total amount measured during the same year being shown in the last column of the table:

| Year. | Milligrams of radium. | Fraction of total. | Year. | Milligrams of radium. | Fraction of total. |
|---|---|---|---|---|---|
| | | *Per cent.* | | | *Per cent.* |
| 914-15 | 285.5 | 27.9 | 1918-19 | [a]1,001.0<br>[b]4,065.2 | [a]7.6<br>[b]30.9 |
| 1915-16 | ........ | ........ | | | |
| 1916-17 | 369.7 | 5.7 | | | |
| 1917-18 | 357.1 | 6.7 | Total | 6,078.5 | |

[a] Nonmilitary uses. [b] Military uses.

## X-Rays.

By costly experience roentgenologists have learned that the protection of themselves from X-rays is of utmost importance. This protection is obtained by the use of lead and of lead-impregnated materials, notably lead glass and lead rubber. When the Bureau began its study of these protective materials it was found that some materials offered for protection were entirely worthless and few of them were as efficient as desired. As stated in the report for last year, the Bureau has been markedly successful in securing an improvement in the quality of these materials.

The study and testing of protective materials has been continued throughout the year, a preliminary determination of the effective absorption of lead glass and of water for radiations of a type widely used by roentgenologists has been made, and the applications of radiography as an aid to various investigations have been studied.

Investigations and tests have been made for the Bureau of Aircraft Production, the Surgeon General's Office, and the Ordnance Department, as well as for other sections of this Bureau.

A paper treating of the early work of the Bureau on protective materials was published in the American Journal of Roentgenology (Vol. V, pp. 472–478; 1918) under the title "Röntgen Ray Protective Materials.." On the invitation of the Western Röntgen Society, a paper treating of the X-ray work and plans of the Bureau was presented before that society at its annual meeting in November.

Roentgenologists are thoroughly awake to the need for the study and testing of all types of X-ray apparatus and materials and are desirous that the Bureau take a commanding position in this work. The many demands made upon the Bureau and the difficulties attending the reorganization of its work on a peace basis have prevented the Bureau from giving to the X-ray work the support that it deserves and requires, but it is hoped that means for remedying this condition may be found in the near future.

## PUBLIC-UTILITY STANDARDS.

### Public-Utility Investigations.

A large and important field of work, including more of engineering and field work than most of the electrical work so far described, is concerned with the various public utilities, particularly electric light and power, gas, street railway, and telephone companies. The work includes (1) scientific and engineering research, (2) the study of public-relations questions, (3) the preparation of specifications regarding the quality of public-utility service, (4) methods of testing and inspection employed by municipalities and commissions, (5) safety rules for use by the utility companies to safeguard their employees and the public, and (6) the collection and distribution of information by published papers and through correspondence.

This work is a natural outgrowth of the research and testing work done by the Bureau of Standards for the public-utility companies for several years. The testing of electrical instruments and meters, of gas lamps and the standards employed in measuring the candlepower and heating value of gas, the life testing of electric lamps, the testing of instruments used in telephone work, research on electrolysis mitigation, and similar investigations and tests connected with the public utilities have all involved to a greater or less degree questions of standards of service in the various public utilities. The Bureau has gradually accumulated a considerable amount of information on these questions and has been able to contribute materially to the establishment of standards of quality of service in several of these lines. Furthermore, it has promoted with marked success the practice of settling disputed questions in this field on the basis of sound engineering and economic principles and of cooperation between interests rather than by legal controversy, and in so doing the Bureau has attained an enviable position as an impartial mediator in such questions. Consequently, during the past two years, when abnormal conditions have given rise to many cases in which readjustment of service standards or of rates has been called for, the public-utility staff of the Bureau has been called upon for an unprecedented amount of work.

### Relation of Bureau to Municipalities and Public-Service Commissions.

In many States the public-service commissions have set standards of service, and the Bureau has cooperated with most of those that have done so. In other States the railroad or public-service commissions have taken no action in the matter, although having authority to do so. Again, in some States there are no public-service commissions to issue regulations or to inspect the quality and safety of the service rendered by the various utilities. In any case the cities and towns must look after their own interests, in whole or in part, and frequently have taken up such matters very successfully. Even where there are well-equipped and active State commissions which have adopted rules and are ready to hear complaints regarding rates or service, a very large responsibility rests upon the municipalities. Few State commissions will ever be likely to have a force of engineers and inspectors large enough to enable them to take the initiative in every case and relieve the municipalities of all the responsibility. On the contrary, if the municipalities are active and enterprising in their own behalf, and if the larger ones have well-equipped public-utility departments which can prepare the city's complaints or requests and take them up to the State commissions for hearing and adjudication, the State commissions will be better able to serve all the municipalities of the State, and the municipalties will enjoy in large measure the advantages as well as the responsibilities of home rule without its greatest disadvantages.

For most cities and many commissions it is a difficult matter to judge the quality of service rendered by its utilities. The studies made by the Bureau are a great help in this connection, but much remains to be done. It will conduce to fairness and good understanding to have the subject studied further and to have specifications as definite and complete as possible made available for all branches of public-utility service.

Obviously, it will never be practicable or economical for any State commission, or city to handle these questions alone. Though they possess large and able engineering staffs or employ specialists for each separate problem, the question of what is good service or whether the service in any given case is adequate, safe, and satisfactory can be settled only by reference to what is done under similar circumstances elsewhere in the country. In other words, standards of good practice and good service are largely determined by general experience and should be studied comparatively, using the experience of the entire country. The Bureau has been doing this for several years, and, although it has not been able to do as much as it would have liked to do, it has done enough to demonstrate the practicability and acceptability of the method. The success and approval which the work has met so far fully justify its greater development. The work of the following five sections is largely in connection with public-utility problems:

## GAS ENGINEERING.

(Standards of gas service; efficiency and economy of manufacture and distribution of gas; studies of gas utilization; by-product fuel processes and related tests.)

### Standards for Gas Service.

A large number of cases where standards for gas service were involved have been handled during the past year, some of which are discussed at greater length below. Among these the work for the Indiana Public Service Commission was the most extensive. The investigation requested by the Maryland Public Service Commission at the Annapolis gas works was well under way at the end of the fiscal year, although the final report was not expected to be available for some time. For the North Carolina Public Service Commission the Bureau prepared a suggested supplement to the public-utilities law of that State giving the commission adequate authority, which they apparently do not now have, to adopt standards for service. A survey of gas-plant conditions in North Carolina had been contemplated, but when it was determined that the commission probably did not have authority to fix standards for service the work was postponed. At the request of the chief engineer of the Virginia Corporation Commission, preliminary assistance has been given looking to the adoption of standards for service in that State.

Municipal problems of more or less importance have been covered during the year for city authorities or gas companies in the following localities: Atlanta, Macon, and Savannah, Ga.; Jacksonville, Miami, Tampa, and Key West, Fla.; Columbia and Anderson, S. C.; Durham, N. C.; Atlantic City, N. J.; Houston, Tex.; Sandusky, Ohio; and Louisville, Ky. In all but one of these cases the locality was visited and conferences with one or more interested parties were held.

The work of the Fuel Administration on standards for gas service, especially committee activity looking to the adoption as a war measure of a low national standard for heating value, received considerable attention, and an extensive report on this matter was presented to the Fuel Administration for their consideration.

During the year the third edition of Circular No. 32, "Standards for Gas Service," was by necessity continued in use, but preparation of a fourth edition has been undertaken. This will be completed in the early part of the fiscal year now opening.

### Indiana Gas-Standards Investigation.

During the latter part of 1918 the Public Service Commission of Indiana received many complaints regarding the quality of the gas service which was being rendered in a number of cities. Investigation showed that in many cases the poorer quality of gas-making materials available under the existing war-time conditions was responsible for deficiencies in service. A proposed new set of rules for gas service in the State was presented at a public hearing held by the commission in October, 1918, but there appeared to be little information available as to what heating value of gas could be economically produced by the various companies under the existing conditions. The State commission therefore appointed a committee, on which the cities, the gas companies, and the Bureau of Standards, as well as the commission itself, were represented, to recommend to the commission the proper heating-value standard for adoption in the State.

Data and plant records of the various gas companies were collected and carefully examined by this committee. Three very comprehensive tests were run at coal-gas plants in the State, and about 14 other plants were visited in order to determine what heating value of gas they might reasonably be expected to produce. A report containing the recommendations of the committee was finally prepared and unanimously accepted by the committee, and has been presented to the State commission.

In this work the Bureau of Standards has taken an active part. One or more members of its staff were constantly on hand during the progress of the field work, and its senior representative assumed charge of this work at the request of the chairman of the committee.

In the report which has been handed to the commission there are embodied several novel features of gas-standards requirements which, it is believed, will lead to a better and more uniform service to the customers of the various companies. In fact, the Bureau of Standards believes that this investigation which has just closed is the most thorough and convincing effort that has been made in connection with the selection by a public-service commission of a heating-value requirement for a State. Furthermore, the engineering data which have been collected should be of considerable value to the gas industry in the future. The information gained here will be useful in many other cases.

### Investigation of Gas Plant at Annapolis, Md.

During the last year or two the local gas company at Annapolis, Md., not only has been unable to operate at a profit, but has not received sufficient income to meet operating expenses. A substantial increase in rates failed to give the necessary financial relief. The Public Service Commission of Maryland, fearing that either another increase in rates or a decrease in the standard of service might ultimately become necessary, requested the cooperation of the Bureau of Standards in determining whether economies or improvements in operation might not be effected which would enable the company to operate more profitably.

A survey of conditions in Annapolis was made and a report submitted to the Maryland Public Service Commission with recommendations as to the management of the gas company. These, if followed out, will ultimately turn a loss into a substantial profit. Possibilities for a considerable extension of business were disclosed, and the Bureau will make detailed recommendations as to the methods it would advise to be pursued in altering and enlarging the plant and other facilities in order to render adequate and satisfactory service.

### Gas-Service Inspections.

At the request of the State public service commissions and municipal authorities in many parts of the country, the gas-engineering section of the Bureau has made service inspections or rendered assistance in regard to these subjects. This work has included visits and field investigations in approximately 14 different localities in addition to a large number of other requests which were cared for by correspondence or conference in Washington. This work has enabled the Bureau to place at the disposal of gas companies and municipalities the experience and advice of the Bureau staff on matters that are very frequently the cause of considerable controversy or public agitation. This work has been especially important during the past year and will continue to be so while the high costs of fuel and labor and the difficulty in maintaining the usual high grade of gas service prevail. In many cases the work of the Bureau has shown where conditions might readily be improved to the advantage of all parties concerned. In other cases the Bureau has merely pointed out that the gas company in question was doing all that could be expected of it under the difficult circumstances then existing.

In general the difficulties noted were the result of the extensive disorganization of the gas industry by war conditions and the shortage of fuels of high grade which are best suited to gas making. These conditions, with which the consumer was not always familiar, together with the general increase in gas rates made necessary by high costs, have caused much public dissatisfaction with gas-company operations, and it is natural that outside assistance of this sort from sources clearly not partisan should have been sought. The reports of the Bureau on the conditions found will probably lead to improvement in the relations between the gas companies and the public, as well as, in some cases, to an actual improvement in the quality of service or operating efficiencies of the companies.

### Gas-Appliance Laboratory Investigations.

The Bureau is cooperating actively with the industrial fuel committee of the American Gas Association in investigations of gas utilization and burner design. In particular the committee is carrying on a general investigation of the various types of atmospheric burners now in use for industrial purposes.

Up to the present time most of the industrial gas burners have been designed by purely empirical methods, and as a result many of them are far from efficient. The proper design of air shutter, gas orifice and burner throat to give a maximum of air-injecting power under conditions ordinarily met with is the part of the problem assigned to the Bureau. This work is an essential preliminary of the investigations which have been in mind for several years, looking to an improvement in the efficiency of use of gas. The results obtained will serve as a test of the theories which have been developed as to the relation between the physical constants of the burner and the characteristics of the gas used, and should show in a clear and simple way the principles which underlie the efficient utilization of gas in ordinary Bunsen-type burners.

### Coking of Illinois Coal.

The great importance during the war period of substituting mid-continent coal for coals from more distant sources, even in by-product coke-oven work, was well recognized. At the request of the War Industries Board, the Bureau of Standards last year made an investigation of a new coke-oven process claimed to be especially suited to this purpose, and in connection with this investigation later conducted a test of a plant in Minnesota, using about 7,600 tons of coal from the Orient mine, Franklin County, Ill. In carrying out these operating tests the Bureau had the cooperation of the Bureau of Mines, and all phases of coal handling, by-product recovery, and laboratory tests were under observation by a staff of 37 Government engineers and chemists employed on the work. In addition, those in charge had the benefit of advice and comment from a considerable number of specialists in the field of coke-oven operation.

All coal used and all by-products obtained were carefully weighed or measured at regular intervals, and samples of each material were taken for analysis. The Bureau of Standards was responsible for the general planning and supervision of the test work. Its representatives made all observations of battery operation, high-temperature measurements, by-product recovery, and chemical-laboratory work on gas and by-products. The Bureau of Mines was responsible for the sampling of the coal, both as it was loaded at the mine and as dumped at the plant. It supervised the weighing, coal-handling, coke-handling, and coke-sampling operations, and made all analyses of coal and coke. Its representatives also made general observations on the character of the coke and operation of the ovens.

In order to test the behavior of the furnace-size coke produced from the Orient coal, arrangements were made to use about 1,800 tons of this material in the blast-furnace plant of the Mississippi Valley Iron Co. Several experts were present during this test, and it was the unanimous opinion of these persons and of the blast-furnace operators that the Illinois coke had shown highly satisfactory results. However, it should be borne in mind that the furnace used for this test was of small capacity, and it is not certain, therefore, that the results in this case would be duplicated in a large-sized furnace.

As a result of the test, it is clearly demonstrated that coke which can be successfully used in a blast furnace can be produced from some of the Illinois coals in the "chamber-type" oven without radical change in the operating methods. However, it appears that the temperature at which Illinois coals should be handled for the production of the best coke is somewhat lower than the best operating temperatures for eastern coals, and, moreover, the speed of coking of the Illinois coals is somewhat less. The yield of gas and by-products from Illinois coal of the kind tested is excellent both in quantity and quality. It should be noted, however, that the coal tested in this case represents one of the best Illinois coals for coking purposes, being lower in ash and sulphur and otherwise superior to many from this field.

### Experimental-Retort Tests of Orient Coal.

In connection with other coke-oven investigations it was thought desirable to carry out a short series of experimental-retort tests of Illinois coals to determine the influence of temperature of coking upon the characteristics of the coke and the quantity and quality of gas produced. This work was done at the Sparrows Point plant of the Bethlehem Steel Co., where apparatus was placed at the disposal of the Bureau through the courtesy of the engineers in charge.

The gas produced at high temperatures was much greater in volume but lower in heating value than that produced at the lower temperatures, not only because of more complete elimination of volatile matter from the coal, but also as a result of the greater decomposition of the heavier volatile matter into gaseous constituents at the higher temperature. At the lower temperatures the coke was very inferior to that produced at the higher temperatures, but in no case was the temperature maintained as high as is generally done in coke-oven practice.

Detailed results for the series of five tests are reported in Technologic Paper No. 134. This paper also includes data given to the Bureau by the steel company covering tests made with the same apparatus during the preceding two years.

### Proposed National Gas-Safety Code.

The Gas-Safety Code has been advanced very little during this year, but a paper on " Tests of flexible gas tubing " has been prepared and will soon be issued as Technologic Paper No. 133. Unfortunately, there is no prospect of much further progress on the code until additional means are available for the Bureau's gas-engineering work. The Bureau of Standards in carrying out this investigation desires to serve as a national coordinating agency to the end that the resulting code may be adequate for the protection of users of gas, and at the same time acceptable to the casualty and fire-insurance interests, the gas companies and their employees, and the gas-appliance manufacturing and selling interests.

It is well known that avoidable accidents due to ignorance, carelessness, or faulty installation result in the loss each year of hundreds of lives and the destruction of property of large aggregate value. It may reasonably be expected that if the code could be completed and adopted throughout the country, these losses would be considerably reduced, both because of the official enforcement of the code and because of its educational value to gas fitters, appliance manufacturers, utility operators, and the general public. The code would also serve to unify practice in gas installations and gas-company operation throughout the country, and such uniformity of practice would not only tend to greater safety, but would also contribute to higher efficiency and to more harmonious cooperation between insurance and gas-company officials.

## ELECTRIC SERVICE STANDARDS.

(Standards of electric service; efficiency and economy of operation of power plants in the generation and distribution of electricity; street-lighting systems; central steam and hot-water heating problems.)

### Standards for Electric Service.

For several years the Bureau has been studying the questions of specifications for electric light and power service and the requirements that should be made by municipalities or by State public-service commissions of the public-utility corporations engaged in furnishing such service. This study was published in 1916 as Circular No. 56, " Standards for Electric Service."

In addition to proposed State rules and specifications for acceptance of types of meters, the circular contains three regulatory ordinances suggested for cities of various sizes, descriptions of commissions' standardizing laboratories, and a complete and exhaustive digest of State rules and of ordinances in force in various cities. The demand for this circular has been large, and it is gratifying to note that the rules, specifications, and ordinances proposed have been made the basis for State rules and city ordinances in many instances.

Even before the circular was published a few States had revised their electric-service rules, and an appendix was added to include the new material. Since its publication several new commissions have been established, the functions of old commissions changed, and service rules have been revised in a number of States. The new laws and revised rules have been collected and are ready for inclusion in a new edition of the circular, which will be completed during the latter part of the next fiscal year.

In all this work the Bureau has profited by the cordial cooperation of public-service commissions, municipalities, and public-service corporations, the National Electric Light Association, and the Association of Edison Illuminating Companies.

### Standards for Street-Lighting Service.

For a year or more the Bureau was engaged in a study of street lighting in its technical and engineering aspects, with particular reference to the requirements that should be put into contracts between municipalities and public-service corporations for furnishing gas and electric street lighting. A number of municipal and private plants were inspected, photometric measurements made, and conferences held with managers and illuminating engineers. The Bureau was receiving the hearty cooperation of municipalities and lighting companies in this work when the war necessitated a discontinuance of much of it on the part of the Bureau, and public-utility companies also found themselves unable to cooperate as fully as they would like to do.

The manuscript of a circular on "Standards for Street-Lighting Service" is partly completed. The scope and completeness of this study of street lighting are indicated by the following proposed table of contents: The purpose and problem of street lighting; the measurement and distribution of light and illumination in street lighting; lamps and accessories used in street lighting; general principles governing the design of a street-lighting system; description of typical street-lighting systems; discussion of contracts for street-lighting service; suggested street-lighting contracts; statistical appendixes. No very active work has been done on the circular during the past fiscal year, but the digest of the literature has been kept up, new contracts obtained and analyzed, and additional data accumulated.

As in the case of standards for electric service, the Bureau seeks, while representing the public interest, to get the utilities' point of view as well, and the study of street lighting will not be published until full discussion and cooperation can be had from public-utility corporations, technical societies, municipalities, and other interested parties. As in other cases, the information gained will be of great service to the people.

### Standards for Heating Service.

At the request of the Public Service Commission of Indiana a study of standards for central station hot-water heating service was begun early in 1918. Field investigations of plants in Ohio, Indiana, and Illinois were made, and conferences were held with their engineers. A proposed set of rules for hot-water heating service was formulated by the Bureau, and after public hearing on the matter these rules were adopted by the Indiana commission substantially as recommended. The manuscript of a circular on steam and hot-water heating service is nearly completed and will be submitted for comment and criticism to the special committee appointed by the National District Heating Association to cooperate with the Bureau, and to other associations and public bodies interested in central-station heating problems. This circular covers the factors affecting adequacy and safety of central-station heating service, the customer's heating requirements, and the various relations with the customer in furnishing such service. It also contains a summary of existing State regulations and of company rules, as well as a set of suggested rules and contracts.

## TELEPHONE SERVICE.

(Systems of telephony; standards of telephone service.)

### Telephone-Service Standards.

The investigation of telephone-service standards is of great importance not only to public-utility commissions but to the telephone-using public at large. Nearly every branch of telephone engineering is involved in such an investigation. Standards of transmission, traffic conditions, and the methods of handling traffic, the equipment used in the various systems, including subscribers' instruments, apparatus used in central office, and private branch exchanges, and the wire plant necessary for subscribers' lines and trunks all have a very direct bearing on the quality and the cost of service rendered the public. The work of the Bureau has been directed along lines which it is believed will best serve all interests concerned. It is seeking to gain, through field and office studies, experimental and theoretical research, and testing, a thorough knowledge of the whole intricate subject of telephony, and through publications, correspondence, and conferences to make its knowledge available impartially to the telephone manufacturing and operating industries, the regulatory commissions, and the telephone-using public.

Detailed studies of the circuits and mechanism of the various automatic or semiautomatic types have been made, and descriptions have been prepared covering the general functions of each switch, the function of each switch element, and the sequence of operation of the elements from the moment the switch is seized in the process of making a call to the time it is released. These studies, together with similar ones of present-day manual systems, supplemented in so far as possible by service observations, will be of value in determining to what extent the different grades of telephone service required under different conditions can be adequately described through standard specifications. Such specifications would be invaluable to public-service commissions in the regulation of telephone utilities with equal justice to the utility and the public it serves.

In order to put into concrete and useful form the information available, the Bureau has in preparation two telephone circulars. The first is intended to give a relatively brief, general description of modern telephone systems and service, and is expected to be published within a few months. The second will describe in considerable detail equipment and service of the type used in cities which have a number of exchanges. In the preparation of this circular the Bureau expects to have the advantage of the continued cooperation of all the telephone interests as well as regulatory commissions, and, as the contents will be submitted to all concerned for criticism and discussion before publication, the circular will not be ready for publication for a considerable time.

### Testing of Telephone Circuits and Apparatus.

While the equipment of the telephone laboratory is still far from complete, apparatus is now available for making all reasonable tests for volume and intelligibility of transmission of telephone transmitters, receivers, repeating coils, and of complete talking circuits. The Bureau is also prepared to test transmitters and receivers for their efficiency, as compared with that of standard instruments.

### Standardization of Telephone Terms.

During the past half year the standards committee of the American Institute of Electrical Engineers, through its subcommittee on telephony, telegraphy, and radio, representing the various telephone interests and the Bureau of Standards, working in cooperation with the corresponding committee of the British Institution of Electrical Engineers, has been actively engaged in standardizing the definition of technical terms employed in telephony. This work was at first limited to the standardization of terms introduced through the advent of machine switching or automatic telephony, but the scope was early extended to include the whole field of telephony.

To date many definitions have been tentatively agreed upon and have been submitted to the British authorities for their consideration. The large number of terms yet to be defined will receive the active attention of the subcommittee and those cooperating with it when meetings are resumed in the fall.

## ELECTROLYSIS PREVENTION.

(Study of the effects of stray electric currents and development and application of methods of reducing damage resulting from them.)

### Electrolysis Problem Among Public Utilities.

The majority of the street railways of the country are operated on the single overhead-trolley plan, with the electric current flowing into the rails through the car wheels after it has passed through the car motors. The current then flows back to the generating station or substation by way of the tracks and earth, some of it, however often flowing through underground gas and water pipes and the lead sheaths of underground telephone and electric-light cables and sometimes through reinforced-concrete structures. The earth conducts electricity by virtue of its moisture and the salts dissolved in it, which render it an electrolyte. Hence when the electric current flows away from iron pipes or lead cable sheaths it carries away iron or lead by electrolytic action, and this in time may seriously corrode the pipes and shorten their useful life, sometimes completely destroying them in a relatively short time. The property damage caused by these earth currents when they are considerable affects to a greater or less degree all the public utilities.

The trouble is the more serious in places where the soil has a greater conductivity than usual and where the conductance of the tracks is small in proportion to the current, and the distance the current travels back to the stations is relatively great. Many remedies have been proposed and tried, but no standard practice for the handling of the return current has ever been agreed upon in this country. As the electric railways have been extended and traffic has become heavier the volume of current handled has increased very greatly, and the resulting destructive effects, which are cumulative with time, have become increasingly evident. In some cases litigation has resulted between the pipe-owning companies suffering damage and the railway companies whose current causes the trouble. But, although the courts have considered the question of legal responsibility, these cases did very little to prevent the trouble in an effective and economical manner.

### Economic Importance of the Electrolysis Problem.

The subject of electrolysis of underground pipes, cables, and other metal structures is one which has been given more attention in recent years than formerly, but it still does not receive the attention in many quarters that its importance deserves. When one considers the enormous value of the pipe and cable properties buried in the streets of cities and forming in many cases transmission networks between cities throughout the country, and considers further that there are very few water, gas, or lead-cable systems which are not more or less subject at some points to electrolytic damage from stray currents, it is possible to form a better judgment of the practical importance of this subject. The water and gas pipe systems of this country alone have an aggregate value at the present time in excess of a billion of dollars, and in addition to this there is a vast extent of underground lead-cable systems belonging to telephone and electric power companies and to municipalities. There are also possibilities of trouble in the case of bridge structures, portions of steel-frame buildings, and piers, which are occasionally exposed to damage from this source.

While the total losses due to shortening the life of underground pipes and cables must be considerable, such loss does not by any means represent the total annual damage due directly to electrolysis. It is well known that the annual loss due to leakage of water and gas from distribution systems is very great. It is true that only a part, and probably a small part, of the total leakage is due solely to electrolysis; but it is only necessary to assume that a few per cent of the total is due to the more rapid development of leaks caused by electrolysis in order to make the total loss resulting from this cause run well into the millions annually.

### Inconvenience and Hazard Due to Electrolysis.

It is not alone the property loss, however, that makes the electrolysis problem one of importance. An important fact is the inconvenience to consumers of water, gas, and telephone service due to the interruption of the service when repairs are made necessary by electrolytic damage. Possible interruption of the service of police and fire-alarm systems is also one of considerable importance to almost every municipality.

Wherever currents are permitted to flow on the underground-pipe systems there is the possibility of electric arcs being formed when pipes are disconnected or when different pipe systems make momentary contact. Accidents of this kind are rare, but they have sometimes occurred, resulting in the loss of life and a considerable damage to property. Cases have occurred also in which leakage of gas resulting from electrolytic corrosion of the pipe has given rise to explosion with disastrous results. Many gas explosions in basements and manholes have occurred, and, although it is difficult to determine what proportion is due to electrolysis, undoubtedly some of them are due to this cause.

A water-pipe line weakened by electroyltic corrosion may even present a fire hazard much greater than would result from interruption of water supply at normal times. In many cities it is quite common practice during bad fires to increase temporarily the water pressure in the district adjacent to the fire. It is very obvious that a badly corroded water main might be capable of withstanding the normal pressure on the system, and thus give no warning of the weakened condition of the pipe, but at the critical juncture during a bad fire when the pressure is suddenly increased the pipe may burst and thus seriously hamper the work of fire fighting. It will readily be appreciated that in any region in which electrolysis damage is in progress to a greater or less extent the mains are far more likely to break at these critical times than at any other period, and thus a real, though indirect, fire and life hazard due to electrolysis must be recognized.

### Current Work on Electrolysis Mitigation and Related Problems.

In the field of electrolysis mitigation the Bureau's work was greatly curtailed during the war, since practically all the men formerly engaged in it were diverted to military problems. Since the close of hostilities more active work has again been undertaken, and most of the investigations mentioned below have been carried out during the last few months of the year.

### Electrolysis Surveys.

In Milwaukee the question of damage by electrolysis has been in dispute for some time, the city having brought suit against the street railway company to restrain it from further damaging the water mains. Since a controversy in the courts did not promise a satisfactory settlement of this difficult technical problem, the Wisconsin Railroad Commission was asked to exercise its authority in prescribing the responsibility to be assumed by the various utilities in dealing with the problem. The commission, recognizing that the first thing necessary was a more complete knowledge of the facts in the case, requested the Bureau to supervise a survey to be made under the authority of the commission. This survey was made in the fall of 1918 and a report of the findings was submitted to the railroad commission in November.

In Wilmington, Del., the Bureau some years ago suggested that the street railway company use a three-wire power-distribution system to avoid electrolysis troubles. Such a system was designed and installed by the company and proved to be thoroughly satisfactory until very recently, when the rapid growth of the city, with consequent heavy increase in the traffic in certain sections, unbalanced the load on the system, so that there appeared to be a possibility of damage, particularly to important telephone cables which pass through Wilmington. Late in 1918 one of the Bureau's engineers made a detailed study of the situation and assisted in the design and installation of supplementary protection to the cables which it is believed will remedy the undesirable conditions which had developed.

During the last spring two electrolysis surveys were made, one in Marion, Ohio, and the other in Brazil, Ind. The Marion survey was made at the joint request of the utilities and the municipality, and the Brazil survey was made at the request of the Indiana State Public Utilities Commission. Reports have been submitted on both of these surveys which are in the nature of preliminary reports, and as soon as the recommendations embodied in these reports have been complied with it is expected that the Bureau will make some additional tests to determine whether additional remedial measures are called for.

### Investigation of Corrosion of Cables in St. Louis.

Shortly before the outbreak of the war, the Union Electric Light & Power Co., of St. Louis, brought to the attention of the Bureau a peculiar case of corrosion of its lead cable sheaths, which appeared, superficially at least, to be very different from that commonly met with in electrolytic corrosion. A few preliminary tests were made in connection with this by the Bureau just prior to the outbreak of the war, but these were dropped when it became necessary to devote all of the energies of the section to the development of war apparatus.

Recently the Bureau again communicated with the Union Electric Light & Power Co. and found that they had not as yet reached any solution of the difficulty and were very anxious to have the Bureau resume the investigation. This was done, and a considerable amount of work has been carried on both in St. Louis and in the laboratories of the Bureau during the past six months. While the investigation is not completed and it is not yet possible to state with certainty the exact cause or causes of the trouble, practically all the evidence thus far obtained tends to show that the trouble is a combination of several causes, chief of which is the fact that during the first few months after the installation of these cable systems they were subjected to very high positive potentials, probably of sufficient magnitude to cause most of the corrosion that is now being observed. Subsequent failures gradually developed, due partly to the elevated temperature at which the cables were operated, which was augmented by a peculiar type of conduit used. The Bureau is at present engaged in investigating a few special questions that have come up, but it is not anticipated that these investigations will change the general conclusion reached.

### Improved Methods for Making Electrolysis Surveys.

With the extension of the work on mitigation of electrolysis it has become more and more evident that the older methods of making electrolysis surveys are decidedly unsatisfactory and sometimes may be misleading. Consequently, attention has recently been given to the development of improved methods of making such surveys. Particular attention has been given to developing methods of measuring the current flowing in pipes and the leakage of current from pipes, instead of following the old procedure of measuring the differences in voltage between the different metal structures concerned in electrolysis. The development of these new methods of measurement has required considerable investigation to determine the practicability of applying various principles in the measuring instruments. While none of these investigations are complete, a number of instruments have been built and have given satisfactory results in laboratory tests. Plans are under way to try out these instruments in measurements under field conditions during the next few months.

### Experimental Work on Electrolytic Corrosion of Lead.

One of the serious types of damage resulting from the flow of stray electric currents is the destruction of the lead sheaths of cables, which results in deterioration of the cable insulation, and consequently in short circuits and destruction of the cables. Because of the contradictory character of available evidence as to the conditions under which such corrosion of lead occurs, it has appeared necessary to do a great deal of laboratory work to determine these conditions; for example, tests have been made to determine the variation of corrosion with varying current densities in earth, sand, and water. In accordance with previous results, it has been found that the corrosion per unit of current is greater when the actual current density is small than when the currents flowing are large. Another condition which affects the rate of corrosion is the percentage of moisture present in the earth or sand. In general, corrosion takes place more rapidly when there is more water present.

In many places, as the demands for power vary, certain parts of the pipe systems are alternately positive and negative, so that at times the current flows from, and at other times it flows into, the metal. There have been marked differences of opinion as to the electrolytic effects obtained under such conditions, and a long series of experiments have been carried on to determine what the effects are. In these experiments specimens of lead have been made alternately positive and negative for different fractions of the time. The relative amount of corrosion has been found to decrease very rapidly when the portion of time during which the specimens are positive is decreased. It appears probable that in such cases some of the metal is actually redeposited on the specimen when the current is reversed. This, however, has not yet been definitely proved.

## SAFETY ENGINEERING AND SAFETY STANDARDS.

**(Study of means of reducing hazard to life and property arising from the use of electricity and from other industrial processes; development and application of safety codes for the prevention of accidents, notably the National Electrical Safety Code.)**

### National Electrical Safety Code.

The Bureau has been engaged for six years in a study of the life hazard in electrical practice and in the preparation and application of the National Electrical Safety Code. In this work it has had the cooperation and assistance of a large number of engineers, many of whom are connected with the electrical operating and manufacturing companies, others being engineers and inspectors of State commissions, municipalities, and insurance underwriters. The various national associations connected with the electrical industry have also cooperated effectively in this work. The importance of having a national code uniform in all the States is realized to be quite as great for accident-prevention rules as for fire-prevention rules, and the advantage of having such a code prepared and presented by a national agency that can study the subject thoroughly and consult all the interests affected is obvious.

The safety code consists of four principal parts, as follows:

1. Rules for the installation and maintenance of machinery, switchboards, and wire in central stations and substations.
2. Rules for the construction and maintenance of overhead and underground lines for the transmission and distribution of electrical energy and intelligence.
3. Rules for the installation and maintenance of electrical apparatus and wiring in factories, residences, and wherever electricity is utilized for light, heat, or power.
4. Rules to be observed by operators in working on or near electrical machines or lines.

This code does not include the matter covered by the Underwriters' Electrical Code, but it is parallel to the latter and consistent with it.

The code is intended to be adopted by State industrial and public-service commissions and municipalities and to be complied with by public-service and industrial corporations. It is also intended to be adopted voluntarily by electrical interests when the code has not been adopted by any administrative body having jurisdiction in their district.

The Bureau's thorough study of the diverse conditions under which electricity is generated, distributed, and utilized, and of the effect of the rules on operating and construction costs, has secured a code which involves no unreasonable expense, but in general assures an adequate measure of safety and a useful standardization of practice. The large number of conferences held in all parts of the country for discussion of preliminary drafts of the code aided largely in its development to the point where it was possible to recommend it for general use throughout the country. The varying conditions in different geographical sections and in thickly and thinly populated districts have been given careful attention.

The code was published originally in two installments for examination and criticism; the operating rules were published in August, 1914, and revised in May, 1915; the construction rules were published in April, 1915. Both operating and construction rules, again revised after a general conference of all interests in Chicago in the spring of 1916, were combined in a single volume, circular No. 54, which was published in November, 1916, with a recommendation for actual field trial.

It has been the intent of the Bureau, as well as the desire of all branches of the industry, that the rules should be revised and extended as experience in their use and the progress of the electrical industry shows revision and amplification to be to the public advantage. The present edition of Circular No. 54 has been exhausted, and a revision is now under way which will be completed before reprinting the circular. In this revision only minor changes in subject matter have been made, but there will be considerable changes in form, with a view to making the code more concise and more convenient for reference. For this purpose the rules will be separated and published in one volume supplemented by separate volumes, one giving explanations of the rules and examples of their application and another engineering data which have been worked out in connection with the development of the code.

### Engineering and Experimental Work in Connection with the Safety Code.

Considerable work has been done on engineering data for the construction of outdoor electrical lines, especially with reference to poles and steel towers for supporting overhead conductors and to the sags of the conductors so supported. Sags have been computed for temperatures other than those used in the original published tables, and steel wires and cables have also been considered. An article by members of the staff on the latter subject was published in the Electrical World.

Experiments for determining the pressure of the wind upon overhead wires and the shielding effect of wires upon each other where they are closely grouped have been carried out. Models were set up in the wind tunnel and currents of air of different measured velocities were caused to impinge upon them. Measurements of the pressure under such conditions showed that there is a definite shielding effect when two or more wires lie in the same plane which is nearly parallel to the direction of the wind. Experiments in the open air which have been planned by the Western Union Telegraph Co. will be carried out with the cooperation of this Bureau.

### National Electrical Safety Code in Practical Use.

The code has now been adopted in one form or another, in part or in whole, by some 20 administrative bodies, and many others have taken favorable action upon it, such as the issuance of bulletins recommending the application of the code. In a few States its application has been made mandatory, notably in Pennsylvania, Wisconsin, and Montana. The code is also being used by the inspection departments of many cities and boards of underwriters. It is being used as a basis for a merit-rating schedule by casualty interests just as the Underwriters' Electrical Code has been used by the fire underwriters for some years. Such schedule ratings should result in emphasizing both the merits and demerits of particular installations from the safety standpoint and tend to reduce accidents by proper financial recognition of each improvement made.

The code is also being voluntarily applied by a large number of utilities and industrial concerns in their own practice. It is receiving the general approval of all these interests as its usefulness is becoming recognized and its advantages are seen to be greater than any minor present inconvenience which its introduction may cause. It is becoming generally understood that the stability in electrical practice provided by such a national standard conduces greatly to the general economy, the necessity for which has been emphasized during this period of national stress.

**Industrial Safety Standards.**

As a result of the work on the National Electrical Safety Code and the numerous points of contact thus established with State authorities and others interested in safety work the Bureau has been called upon to enlarge the scope of this work and to consider safety requirements in other than the electrical industry.

In 1917 the United States Employees' Compensation Commission undertook a general inspection of the arsenals and navy yards of this country from the safety standpoint. The National Electrical Safety Code was utilized as a standard of reference in this work. In order to improve the conditions found safety engineers were appointed by the War and Navy Departments in each one of the navy yards and arsenals, and the engineers so appointed held several conferences for the purpose of formulating definite safety standards for application in the Federal establishments. Representatives of the Bureau were invited to attend these conferences, and the Bureau was later asked to undertake the revision and codification of the tentative rules which were drawn up to prevent accidents. A set of standards, including the National Electrical Safety Code, was adopted by the safety engineers as a result of this work, and these standards have been applied by the War and Navy Departments.

The need for carrying out work of this kind in a more comprehensive way and with results which should be more generally applicable soon became evident, and the Bureau, consequently, has undertaken a study of other safety rules and has begun the formulation of a series of national industrial safety codes. These will accomplish for other industries what the National Electrical Safety Code has done for the electrical industries. They will be available for the use of State commissions, municipal inspection departments, casualty insurance companies, and others concerned with the application of such rules. The work will be carried out with the cooperation of State and municipal authorities, manufacturers, insurance organizations, technical societies, and other bodies concerned with such matters.

In order to arrange for more complete cooperation in this work and to insure the coordination of the efforts of all parties concerned, a conference was held at the Bureau on January 15, 1919, which was attended by more than 100 representatives of different organizations concerned with safety standards. This conference agreed that the Bureau of Standards was the most suitable agency to take the leadership in this work. It is expected to hold a second conference in a few months to consider further the best means of securing cooperation and of proceeding with the work.

In the meantime the Bureau staff has prepared tentative drafts of rules covering the requirements to prevent accidents, as follows:

National Elevator-Safety Code; National Code for Safeguarding Machines and Machine Drives; National Code for the Protection of Head and Eyes of Industrial Workers; National Code for Safeguarding Remote Control Apparatus. Other industries will be considered as rapidly as the work can be taken up, but the present staff of the section is not sufficient for making very rapid progress.

## 3. HEAT AND THERMOMETRY.

[Establishment of the standard scales of temperature throughout the range of measurable temperatures; testing and standardization of thermometers, pyrometers, and other temperature-measuring instruments; determination of specific and latent heats, heats of reaction, melting and freezing points, and other properties of materials in the determination of which precise heat and temperature measurements are the principal requirement; standardization of calorimeters; production and distribution of standard heat and temperature samples; industrial applications of heat and temperature measurements; determination of fundamental engineering data involving thermal constants; determination of the fire-resistive properties of structural materials; investigations relating to automotive power plants, fuels, and lubricants.]

### Thermometer, Pyrometer, and Heat Tests.

The tests completed in the division during the year are summarized as follows:

The number of mercurial thermometers of all kinds, exclusive of clinical theremometers, submitted for test was 4,832, of which 4,100 received certificates or reports. Among those submitted were 479 Parr calorimetric thermometers, 23 high-precision calorimetric thermometers, 121 Beckmann thermometers, 30 clincal standards, and the remainder laboratory and special thermometers of various types, ranging from below 0° C. and up to 500° C. Ninety-nine airplane thermometers of various types were tested for the War and Navy Departments. Of the 19,773 clinical thermometers submitted, 18,503, or 94.1 per cent, were certified. In addition to the above there were tested 11 platinum resistance theremometers and 6 special thermocouples, while freezing-point determinations were made on 75 samples of materials.

In the high-temperature laboratories the following tests were made: Ninety-four thermocouples, 13 indicating instruments for thermocouples, 5 homogeneity tests of thermocouples, 8 optical pyrometers, 9 pyrometer lamps, 2 absorption glasses, 70 melting points, and 7 special tests.

One hundred and sixty samples of metals with certified melting points were distributed.

The heat-measurements laboratory distributed 204 standard combustion samples. Three gas calorimeters were tested. The heating values of a number of samples of gasoline and fuel oil and the thermal conductivities of a number of insulating materials were determined.

A considerable amount of testing done by the section on automotive power plants, fuels, and lubricants, being of an investigative character, is summarized under the work of that section.

The work of testing done in this division was about equally divided between work done for the Government and that done for the public.

### Publications.

The following papers relating to the work of the division have been published during the year or are in press. These papers are briefly referred to in various sections of this report:

Misleading Certificates for Clinical Thermometers: Jour. Am. Med. Assoc., February 8, 1919; Am. Druggist and Phar. Rec., February, 1919; The Military Surgeon, vol. 44, p. 297, 1919.

Tolerances for Laboratory Thermometers: Published as a preliminary circular letter.

Thermometers for Airplane Engines: Fourth Ann. Rept. of the Natl. Advisory Com. for Aeronautics.

A Standardized Method for the Determination of Solidification Points, Especially of Naphthalene and Paraffin: Bureau of Standards Scientific Paper No. 340.

The Standardization of the Sulphur Boiling Point: Jour. Am. Chem. Soc., vol. 41, p. 745, 1919; Bureau of Standards Scientific Paper No. 339.

Resonance and Ionization Potentials for Electrons in Metallic Vapors: Phil. Mag., vol. 36, p. 64, 1918.

Electronic Frequency and Atomic Number: Phys. Rev., vol. 12, p. 115, 1918.

Low Voltage Discharge in Sodium Vapor: Jour. Wash. Acad. Sci., vol. 8, p. 513, 1918.

Some Peculiar Thermoelectric Effects: Jour. Wash. Acad. Sci., vol. 8, p. 545, 1918.

Melting Points of the Chemical Elements and Other Standard Temperatures: Bureau of Standards Circular No. 35.

Ionization and Resonance Potentials for Electrons in Vapors of Magnesium and Thallium: Phil. Mag., vol. 37, p. 33, 1918.

Ionization and Resonance Potentials for Electrons in Vapors of Arsenic, Rubidium, and Cæsium: Phys. Rev., vol. 13, p. 59, 1919.

Efflux of Gas Through Small Orifices: Bureau of Standards Scientific Paper.

Fire Tests of Concrete Columns: Proc. Am. Concrete Inst., vol. 15, 1919.

A Comparison of the Heat Insulating Properties of Some of the Materials Used in Fire-Resistive Construction: Bureau of Standards Technologic Paper No. 130.

Fuel Economy of Automotive Engines: Jour. Soc. Automotive Engs., vol. 4, 1919.

Pyrometry: Liddell's Handbook for Chemical and Metallurgical Engineers.

The following 11 papers are to appear in the Transactions of the American Institute of Mining and Metallurgical Engineers:

Thermoelectric Pyrometry.
Temperature Measurements in Rotary Cement Kilns.
Radiation and Optical Pyrometry.
The Melting Point of Refractories.
High-Temperature Control.
Recording Pyrometry.
Heat Treatment of Glass.
The High-Temperature Scale.
Metals for Pyrometer Standardization.
Characteristics of Glass in the Annealing Range.
High-Temperature Thermometers.

The following 21 papers will be published in the fourth annual report of the National Advisory Committee for Aeronautics:

Spark-Plug Defects and Tests.
Properties and Preparation of Ceramic Insulators for Spark Plugs.
Effect of Pressure and Temperature on the Sparking Voltage.
Heat Energy of Various Ignition Sparks.
Temperature in Spark Plugs Having Brass and Steel Shells.
The Subsidiary Gap as a Means for Improving Ignition.
Characteristics of High-Tension Magnetos.

The work described in the above seven papers relating to ignition systems was done with the active cooperation of the electrical or ceramic division of the Bureau.

Synopsis of Aeronautic Radiator Investigations for 1917–18.
General Analysis of Radiator Problems.
General Discussion of Test Methods for Radiators.
Head Resistance Due to Radiators.
Effects of Altitude on Radiator Performance.
Results of Tests on Radiators for Aircraft Engines.
Some Problems of Radiation.
Effect of Compression Ratio, Pressure, and Temperature on Power.
A Study of Airplane Engine Tests.
Power Characteristics of Fuels for Aircraft Engines.
Description of Altitude Laboratory.

Carbureting Conditions Characteristic of Aircraft Engines.
Metering Characteristics of Carbureters.
Effect of Water Injection on Gas-Engine Performance.

The following papers relating to fuels and lubrication are the work of the division of miscellaneous materials of the Bureau:

Viscosity of Gasoline: Bureau of Standards Technologic Paper No. 125.
Report on "Tag" Closed Flash-Point Tester: Proc. Am. Soc. for Testing Mat., Vol. 19; 1919.

**Information Furnished.**

Hundreds of letters and reports relating to the work of the heat division were prepared in reply to requests for information on testing of temperature-measuring instruments, methods of temperature measurement, industrial temperature installations, melting points, specific heats, heats of combustion and other thermal constants, calorimetry, heat transfer and thermal conductivity, fire-resistive properties of structural materials, industrial fire hazards, fire prevention, safety of combustibles in storage and shipment, liquid fuels, lubricants, automotive power plants, etc. Many engineers and technical men have visited the laboratories for consultation on special problems. A number of devices were submitted for examination and criticism.

**Outside Relations.**

The work of this division has served many National, State, and municipal bureaus, engineering and technical societies and committees, testing and research laboratories, and many industries in which the measurement or control of heat and temperature are of fundamental importance.

The thermometer laboratories have cooperated with the Standards Department of the State of Massachusetts in matters relating to the testing of clinical thermometers; with manufacturers and testing laboratories on matters relating to temperature measurement and the testing of thermometers; with the Customs Services on the standardization of tests required in collection of import duties; with the military services, by making investigations relating to airplane thermometers; and with the American Association of Clinical Thermometer Manufacturers.

The high-temperature laboratories have cooperated with the representatives of many industries on matters relating to the measurement or control of high temperatures. Papers have been presented at meetings of the American Physical Society, the Optical Society of America, and the Philosophical Society of Washington. The section is represented on committees of the National Research Council and the Optical Society of America.

The section on heat measurements undertook at the instance of the Bureau of Mines, certain low-temperature investigations closely related to the recovery of helium, an extensive investigation of torpedo-power plants for the Bureau of Ordnance of the Navy, and assisted the Bureau of Aircraft Production in a research on captive balloons. Numerous tests of special appliances were made for the Inventions Section of the General Staff, United States Army.

The section on thermodynamics has been represented on committees of the American Society of Mechanical Engineers and the National Research Council.

The low-temperature laboratories have cooperated in special tests for various military agencies and have supplied liquid air to a number of research laboratories.

Members of the section on fire resistance of materials and fire prevention have participated in committee activities of the National Fire-Protection Association, the American Concrete Institute, and the American Society for Testing Materials. The section was also represented on a committee of the War Department engaged in the standardization of equipment. The investigations on the fire-resistive properties of structural-steel building columns are being conducted in cooperation with the Associated Factory Mutual Fire Insurance Cos., and the National Board of Fire Underwriters.

A large part of the work of the section of automotive power plants has been done under the direction of the National Advisory Committee for Aeronautics and in close cooperation with the following agencies: The Bureau of Aircraft Production, the Division of Military Aeronautics, the Motor Transport Corps, the Inventions Section of the General Staff, the General Engineer Depot, the Engineering Division of McCook Field, the Bureau of Steam Engineering, the Bureau of Mines, the Fuel Administration, and the Society of Automotive Engineers. The section was represented on the Interallied Commission on Specifications for Petroleum Products, and on the Committee for Standardization of Petroleum Specifications.

The Bureau is greatly indebted to many manufacturers of automotive power plants, airplanes, and accessories for supplying materials and test specimens required in the investigations carried out in these laboratories. Particular acknowledgment is due in these respects to the Atlantic Refining Co., the Wright-Martin Aircraft Corp., the manufacturers of spark plugs, magnetos, carbureters, and radiators, and the refiners of lubricating oils.

## THERMOMETRY.

(Researches on the standard scale of temperature and thermometric fixed points from the lowest attainable temperatures up to about 500° C.; maintenance of working standards within the above range; methods of standardizing temperature-measuring instruments, such as liquid in glass thermometers, vapor-pressure thermometers, resistance thermometers, thermocouples; the testing and certification of temperature-measuring instruments; methods of measuring temperatures.)

### Clinical Thermometers.

The matter of misleading certificates for clinical thermometers, referred to in the last annual report, has continued to demand attention. Many manufacturers and dealers have issued certificates which were so worded as to lead the purchaser to believe that the thermometer accompanying the certificate had been certified by the Bureau of Standards. An official letter calling attention to this practice, accompanied by illustrations showing types of these misleading certificates, was published in several of the leading medical and drug journals of the country.

The Bureau has assisted the Department of Standards of the State of Massachusetts in the preparation of testing regulations relative to the enforcement of recent legislation by that State in reference to the sale of clinical thermometers.

### Tolerances for Laboratory Thermometers.

In the certification of laboratory thermometers, as in the case of many other measuring instruments, it has been necessary to define certain limits within which the indications of the instruments must be correct. Thermometers found correct within the required limits receive certificates showing the corrections found at the several test points. If the thermometers are not correct within the tolerances, or are otherwise defective, they are refused certification, although, for the convenience of the owner, a report may be issued giving the corrections resulting from the test and stating the reasons why the thermometer was refused certification. A Bureau certificate thus, in addition to the information furnished in the table of corrections, is an indication that the thermometer is of satisfactory quality. A statement of the proposed tolerances applicable to different types of thermometers was issued during the year to manufacturers and others interested in the subject. The tolerances, based on long experience in testing thermometers, were tentatively adopted July 1, 1919, with a view to their subsequent revision, if necessary. The tolerances and other requirements finally adopted will be included in the next revision of Circular No. 8, on the Testing of Thermometers.

### Airplane Thermometers.

The work in connection with the development of thermometers for airplane engines was continued this year.

In addition to routine tests of instruments submitted by the Army and Navy, special tests were made from time to time, including vibration tests, tests to determine the variance between readings taken on rising and falling temperatures, tests for lag of reading, etc.

A class of instruction on the construction and use of aviation instruments was conducted for naval aviators by the Bureau at the request of the Navy Department. A lecture on airplane thermometers was given by a member of the section before this class. These officers also visited the laboratory and were shown the methods employed in testing airplane thermometers.

A circular on airplane thermometers was prepared and distributed to departments of the Government, manufacturers, and other interested parties. This circular was revised and has been submitted to the National Advisory Committee for Aeronautics for publication in their report.

### Standardization of the Sulphur Boiling Point.

The necessary precautions to be observed in the use of the sulphur boiling point as a fixed point of the thermometric scale are described in a paper published under the above title.

### Standardized Solidification Test.

The work of standardizing a method for the determination of the solidification point of naphthalene, undertaken in cooperation with the laboratories of the Customs Service, was brought to a close during the year. The results of the comparative tests based on this method were received and assembled. The excellent agreement obtained by the various laboratories among themselves and with the Bureau indicated the method as adopted to be very satisfactory.

The method has been applied to the determination of the freezing points of other substances. A Bureau publication describing the method and summarizing the results of the work is now in press.

### Thermometer Comparator.

During the year a new electrically heated thermometer comparator, employing stirred molten metal to secure uniformity of temperature, was designed, constructed, and put into use. The thermometers are inserted into thin closed-end steel tubes dipping into the molten metal. The temperature distribution is uniform to within about 0.1° C. over a length of about 35 centimeters, from a point about 10 centimeters below the top of the bath. This comparator has proven very satisfactory for the testing of thermometers in the interval 300 to 550° C., and it is believed that similar comparators will find considerable application in the pointing and testing of thermometers by manufacturers.

## HIGH TEMPERATURES.

**(Researches on the standard scale of temperature and thermometric fixed points in the interval from 500° C. up to the highest attainable temperatures; maintenance of working standards in the above range; standardization and distribution of standard samples for thermometric fixed points [for example, a series of pure metals of certified melting points]; methods of standardization and the testing and certification of pyrometers, such as thermocouples, resistance pyrometers, pyrometer galvanometers, optical pyrometers [including absorption glasses and color screens], radiation pyrometers, etc.; physical properties of materials at high temperatures, such as emissivity [monochromatic and total], specific heats, melting points [of refractories, metals, fire brick, etc.]; ionization and radiation in gases and vapors, etc.; industrial pyrometry and the measurement of the temperatures in industrial processes; the annealing of glass.)**

### Investigations in Electronics.

Two general types of inelastic impact between an electron and an atom may occur. The first of these results in an orbital shift of the electrons bound in the atom, and the second in the complete removal of an electron or ionization of the atom. The respective potential differences through which an electron must fall to acquire sufficient velocity for these two types of collision to occur are known as the resonance and ionization potentials for the particular metal in question. The determination of these constants has been continued. Work of this character is of theoretical interest from the standpoint of pure physics, and of practical interest in that it furnishes further evidence toward an explanation of the phenomena of ionization and related problems which arise in the design of vacuum tubes for wireless telephony and telegraphy, rectifiers, etc.

Five papers have been published this year on the above and related subjects, two appearing in the London Philosophical Magazine, two in the Physical Review, and one in the Journal of the Washington Academy of Sciences. One additional paper is in preparation. The constants for 12 different metals have been determined. The results have been correlated with existing spectroscopic data and have also been used for a determination of the universal constant of action giving $h=6.55\times10^{-27}$ erg seconds. Spectroscopic series in lead and arsenic have been predicted on the basis of the data for these elements.

### Melting Points of Chemical Elements and Other Standard Temperatures.

A revison of Circular No. 35 makes the data on standard fixed temperatures fairly complete. The edition has been exhausted, and a new edition is in preparation in which a more complete discussion of the high-temperature scale adopted by this Bureau will be presented.

### General Pyrometry.

A treatise on the general methods of pyrometry applicable to the chemical and metallurgical industries is in process of preparation.

### Thermoelectric Pyrometry.

Thermoelectric pyrometry is the most important subject, industrially, in the field of high-temperature measurement and control. An extensive paper on this subject has been prepared as one of the Bureau's scientific publications, in which are treated the fundamental methods employed, necessary precautions which must be observed in the use of the various instruments, and general information of importance in technical practice. The above paper is the most complete treatise on recent developments in industrial thermoelectric pyrometry.

### Radiation and Optical Pyrometry.

Above 1,500° C. radiation and optical pyrometers afford practically the only feasible method of temperature measurement, and for many processes below this temperature these instruments have proved of great value in the temperature control of industrial processes. A paper, published in the Transactions of the American Institute of Mining and Metallurgical Engineers, under the above title, describes the various instruments and methods employed, and gives in simple form the theories upon which they are based. Many specific applications are discussed, as, for example, the measurement of the temperature of glowing platinum gauze employed as a catalyzing agent. This latter problem arose in the process of nitrogen fixation in the manufacture of explosives. Various tables of data useful in computing temperature measurements are summarized in convenient form.

### Recording Pyrometry.

One of the important features of thermoelectric and radiation pyrometry is that printed records of the temperature of a process over an extended interval of time can be readily secured. Many forms of instrument are now manufactured in this country which produce such records automatically. Thus, an operator may be instructed to heat a furnace at a definite rate, and a printed record is available to show whether or not the instructions have been followed. In a paper under the above title, published in the Transactions of the American Institute of Mining and Metallurgical Engineers, the methods employed in recording pyrometry have been considered from the point of view of their industrial applications.

### High-Temperature Control.

Not only is it desirable to obtain a printed record of the temperatures in any particular process, but it is essential to have some means whereby a specified rate of heating or cooling may be readily followed. Various methods are employed for this purpose. In certain large installations the temperature-measuring apparatus is centralized by use of a switchboard system similar to the ordinary telephone switchboard. The control operators measure all the temperatures and instruct the operators of the furnaces by means of pneumatic-tube communication or signal system with colored lights. In certain processes the entire control may be made automatic, even to the regulation of valves in a gas or oil-fired furnace. If the temperature of the furnace is too high, the supply of fuel is decreased automatically. A paper has been prepared for publication in the Transactions of the American Institute of Mining and Metallurgical Engineers, in which are discussed the applications of the various processes employed for manual and automatic temperature control.

### Melting Point of Refractories.

A knowledge of the melting points of fire bricks, cements, etc., used in furnace construction is necessary in order that the proper factor of safety for the operation of any furnace may be known. A paper under the above title discusses the methods employed for such determinations and the precautions which must be observed, in order that reliable measurements may be obtained. When it is realized that the failure of a large furnace in certain industrial operations may entail losses amounting to thousands of dollars, it is readily appreciated that a thorough study of the thermal properties of the materials entering into the construction of the furnace is necessary.

### Heat Treatment of Glass.

War conditions affecting the production of optical glass demanded a more thorough investigation of the annealing processes. To establish effective and economical methods of operation in annealing, it is necessary to determine the practicable annealing temperature range and to investigate certain physical characteristics of the glass in that range. This was done for many different optical glasses. As a result of these investigations, certain relatively simple tests for determining the practical annealing range and annealing procedure for any given glass have been established. An investigation of the distribution of the stresses, the presence of which in the glass necessitates annealing, is also under way with the purpose in view of determining the practicability of establishing standards for the degree of annealing and of studying the relative efficiency of different annealing procedures. Two papers relating to these subjects have been submitted for publication, and a third is in preparation.

### Temperature Measurements in Rotary Portland-Cement Kilns.

In connection with an investigation of certain phases of cement manufacture, the Bureau was called upon to measure the temperatures in the sintering zone, rear end, and stacks of a 125 by 8 foot dry-process, coal-fired rotary kiln. Previous to this work no accurate methods of pyrometric measurements in the sintering zone had been described. Using a disappearing filament type of optical pyrometer, and on stopping the kiln, coal, and air supply for a few moments at a time, a series of temperature-time curves, showing measurements on the lining uncovered by clinker, gave the temperature of the kiln. By means of such data burning temperatures and chemical composition of the clinker may be correlated with the object of improving the quality of the finished product. A paper on this subject has been submitted for publication.

### Coke-Oven Investigation.

The work described in the last annual report has been completed. Methods of temperature measurement in the process of coking were successfully applied to two types of ovens. The form of the temperature-time curve during coking is an important factor in the production of high-grade coke. A full report of the experimental work is being prepared.

### The High-Temperature Scale.

The temperature scale, unlike many other standards of measurement, can not be fixed in terms of a concrete standard. Thus the scale can not be extended by multiplication or division, as is the case, for example, with the meter, the kilogram, the ohm, etc. From the lowest attainable temperatures to the highest temperatures at which a gas thermometer may be employed the latter instrument is used to establish the absolute scale of temperature. For temperatures above the range of the gas thermometer use is made of certain well-established radiation laws. These methods of reproducing the temperature scale each time it is to be used are too elaborate for practical purposes. A number of fixed and accurately reproducible temperatures, such as the melting points of pure metals and the boiling points of certain pure substances, are, therefore, carefully determined on the standard scale of temperature, as defined above, and these fixed points are subsequently used for reproducing the working-temperature scale. The use of such fixed points is illustrated in the following section on standard temperature samples. A paper has been prepared in which are discussed the most important available data relating to fundamental determinations of important fixed points suitable for a definition of the standard working scale of temperature. Values accepted by this Bureau for the definition of its temperature scale are considered in detail, together with methods of interpolation of the temperature scale between these fixed points and the extension of the scale to the highest temperatures.

### Standard Samples for Thermometric Fixed Points.

The Bureau issues samples of various metals the melting or freezing points of which have been determined with high precision on the basis of the temperature scale defined as discussed above. By this means the fundamental temperature scale may be distributed to the industries, arsenals, navy yards, universities, and technical laboratories. The demand for these standard samples has been so great that metals are now procured in ton lots when possible. One ton of lead, one ton of copper, and several hundred pounds of zinc and tin have been secured this year. This material is carefully sampled and accurate measurements of the melting points obtained. One ton makes about 1,000 standard samples. A paper has been prepared describing the various samples issued, the chemical analyses, and the methods employed for determining the melting points.

## HEAT MEASUREMENTS.

(Measurement over a wide range of temperatures of thermal properties of materials, such as specific heats, latent heats, pressure-volume-temperature relations for liquids and gases; heats of reaction, particularly heats of combustion of solid, liquid, and gaseous fuels; heat transmission and thermal conductivity; development of calorimetric apparatus and methods; and of methods for temperature control, pressure measurements, measurement of heat transmission, etc.)

### Standard Heat Samples for Use in Calorimetry.

These samples of certified heating value are used in the standardization of fuel calorimeters. The materials issued were naphthalene, benzoic acid, and sugar. The stock of benzoic acid was exhausted several years ago, and until recently no satisfactory material to replace it had been obtainable. The stocks of benzoic acid and naphthalene were renewed and standardized during the year.

### Properties of Methane.

One of the investigations having a military application which was undertaken by the section was the determination of a number of the thermodynamic properties of methane. The knowledge of these properties was very urgently desired by the Bureau of Mines, which was in charge of the production of helium on a large scale for use as a noninflammable balloon gas as a substitute for hydrogen. This project, which constitutes a brilliant engineering achievement, depended on the recovery of the small helium content of certain natural gases. Systematic surveys had shown helium to exist in such amounts as to render this hitherto rare element available in such enormous aggregate quantities as to make its use for military balloons and dirigibles perfectly feasible, if the recovery could be effected at a tolerable cost.

The design and operation of the machinery to effect this recovery most efficiently required a knowledge of the properties of the chief constituent of the natural gas, namely methane.

The properties of methane which were determined by this section were the following: Latent heat of vaporization, specific heat of saturated liquid, specific heat of gas, specific volume of liquid, specific volume of gas, and vapor pressure.

Inasmuch as the accurate measurement of thermodynamic properties of fluids is extremely difficult at best, and, furthermore, as the temperature range throughout which these properties of methane were of interest was far outside the customary range—namely, from 200° to 300° F. below the freezing point of water—the research was taken up with caution and reserve as to the probability of its yielding definite results early enough to be of use to the helium project.

The urgency of the need for the data, combined with the fact that any progress in this comparatively neglected but important field of research would have an intrinsic industrial value, made the attempt seem advisable.

A method for control of low temperature which could be applied to methods of heat measurement was developed, apparatus designed and constructed, defects discovered and remedied, and technique of manipulation acquired in this range of physical measurement. The outcome has been remarkably fortunate in that not only were reliable figures obtained for most of the important properties of methane, but also valuable progress and experience have been acquired which constitute an opportunity for continuation of similar work on other substances, in order to obtain thermodynamic data of importance in technical and scientific work.

As examples of the numerous details in technique of physical measurements involved in this research, wherein especial developments were established, the following two may be noted briefly:

### A Calorimeter Envelope or Containing Vessel for Conserving the Heat of a Calorimetric System at Low Temperatures.

This calorimeter envelope is of copper and is hermetically sealed so as to permit evacuation. It is brought to the desired low temperature and controlled by a stream of air, cooled by expansion, tempered by an electric heater, and led through a complex laborinthine tubular network which effects uniform temperature distribution, thus enabling heat losses to be annulled. This is a novel method for thermal control of a calorimeter envelope.

### An Experimental Study of Methods for Measuring Specific Heat of Gases.

This particular branch of calorimetry is of especial difficulty, owing to the relatively low heat capacity of a given volume of gas, and the most promising method is to pass a rapid stream of gas at a constant rate through an apparatus called a flow calorimeter, in which the temperature is measured both before and after the addition of a measured quantity of power electrically supplied, the system being so constructed as to avoid unmeasured losses of heat during the process. Several designs of such apparatus suited to low-temperature work have been evolved, constructed, and studied with favorable results as to the prospective ultimate perfection which will permit specific heats of gases to be measured with facility and with definite accuracy.

### Properties of Ammonia.

An extensive series of measurements of the vapor pressure of ammonia was completed during the year. The precision obtained in these measurements was high, values being consistent to 0.01° C. or better, except at the lowest temperatures. It is believed that the results obtained are sufficient to meet the demands of engineering and scientific work for many years to come. The range of temperatures covered is from —75° C. to +70° C., which is beyond the range required in refrigeration engineering. The results are being prepared for publication.

With the completion of this work there are available, for the first time, complete experimental data on the properties of liquid ammonia and its saturated vapor, to replace the meager and unsatisfactory data previously available for the calculation of tables of the properties of ammonia.

### High-Pressure Gauges.

A 15-atmosphere mercury manometer and a 100-atmosphere piston gauge, constructed several years ago, have been used in several series of measurements during the year and have been intercompared within the range of pressures of the mercury manometer. The piston gauge in particular has been found to be capable of very precise measurements. While this satisfactory performance depends upon good design and correct manipulation, it is nevertheless true that the satisfactory performance depends upon the accuracy with which piston and cylinder are made and fitted to each other, more than upon any other single factor. This very excellent work was done in the Bureau's instrument shop. A description of the gauges and the methods of calibration and use is being prepared for publication.

### Gouy Thermoregulator.

This type of regulator, described by Gouy in 1897, appears to have been very little used, although in many cases great improvement in thermostatic control can be obtained by its use. The essential feature consists in controlling the electric heating current through an oscillating contact instead of the fixed contact usually employed. The device has been extensively used in the laboratory during the year, and a paper calling attention to its usefulness and to some of its characteristics has been prepared.

### Captive Balloons.

The section cooperated with the Science and Research Division of the Signal Corps (and later with the Bureau of Aircraft Production) in certain important tests relating to captive balloons.

### Special Heat Tests.

Tests were made for the Inventions Section of the General Staff of the Army of a small refrigerating machine under consideration for use in cantonments, also of a number of oil burners designed for use in Army cookstoves. The thermal conductivities of a number of samples of lubricating oil were measured in connection with the lubrication investigation being conducted at the Bureau.

## THERMODYNAMICS.

(Consultation and research work in technical physics or the physics of mechanical engineering, in particular, applied hydro, aero, and thermo dynamics.)

### Efflux of Gases Through Small Orifices.

An important industrial method of metering natural gas requires an auxiliary determination of the specific gravity of the gas. The usual method of determining the specific gravity is dependent on the time of efflux through small orifices. This method was found to be subject to large errors. An elementary theory of the effects of viscosity and thermal conductivity of the gas upon the time of efflux was developed and applied to the observations and shown to account for most of the observed facts. A paper under the above title, prepared in cooperation with a member of the chemical division, has been approved for publication.

### Hydraulics.

A theoretical investigation has been undertaken of the resistance of pipes and Venturi meters to the flow of water and other fluids, concerning which there is need for a more systematic general study and analysis of the available experimental data than has yet been published. In the study of Venturi water meters a probable explanation has been found of a puzzling anomaly observed in the behavior of Venturi air-speed meters, which may lead to the improvement of these instruments.

### Dimensional Methods as Applied to Physical Problems.

In all of the work of this section material is continually being collected for a publication on the dimensional methods of attacking problems in technical or engineering physics. This very useful method is fast coming to more extended employment, but there is no textbook or treatise on the subject, although one is needed. It is hoped that this want may be supplied.

### Heat Transfers.

Some time has also been devoted to the question of planning for research in heat transfer for the subcommittee on this subject of the American Society of Mechanical Engineers, of which the chief of the section is a member.

## LOW TEMPERATURES.

(Production of low temperatures down to those of liquid hydrogen [ultimately liquid helium]; preparation and storage of pure gases; development of methods of producing and maintaining low temperatures; liquefaction and separation of gases at low temperature; special tests requiring the facilities of the low-temperature plant.)

### Operation of Plant.

The liquid-air plant has been operated once or twice a week. Since the liquid air can be stored for several days, this has made it possible to keep a supply in stock the greater part of the time. It has been used for investigations in the low-temperature laboratory, and supplied to various other laboratories at the Bureau, and also furnished to a number of other institutions in Washington and the vicinity.

The carbon-dioxide, low-temperature system was operated almost daily to provide cooling for thermometer comparators, the investigation of refrigeration constants, the testing of aviation instruments, and other investigations.

The large, high-pressure air compressor was employed not only for the production of liquid air, but also to supply compressed air for the production of low temperatures in the apparatus of the thermal-expansion laboratory, the development of new oil-burning apparatus, and other purposes.

Generators for acetylene, hydrogen, and oxygen were maintained in operation, and these gases were supplied to other laboratories.

### Liquefaction of Hydrogen.

During the year a new electrolytic hydrogen generator, two gas holders, each of a capacity of 90 cubic feet, and a four-stage hydrogen compressor were installed. As soon as some additional equipment, such as pumps, purifying trains, etc., are secured, means will be available for the efficient production of liquid hydrogen in considerable quantities.

### Air Liquefiers.

Two small air liquefiers were constructed for the Bureau of Mines for use in connection with the work on the helium project.

### Methane Investigation.

The investigation of the thermal properties of methane, undertaken on account of its importance in the production of helium for use in balloons, which investigation is described elsewhere in this report, is being carried out in the low-temperature laboratories with the use of the equipment where available.

## FIRE RESISTANCE OF MATERIALS AND FIRE PREVENTION.

(Standardization of fire tests; fire tests of structural materials and structures; investigations to develop engineering data relative to the fire-resistive features of building construction; investigation and testing of fire-retarding devices; investigation of building codes and fire codes; cooperative work on fire prevention.)

### Fire-Resistive Properties of Structural Materials.

The object of the investigations on the fire-resistive properties of structural materials is to furnish architects, construction engineers, builders, State and city building bureaus, insurance interests, and others with fundamental engineering data relating to the behavior and safety of various types of building material and construction when exposed to different conditions met with in fires.

**Fire Tests of Building Columns.**

*Tests Completed.*—The series of fire tests of building columns conducted jointly by the National Board of Fire Underwriters, the Associated Factory Mutual Fire Insurance Cos., and the Bureau of Standards was completed during the year. The whole series consists of 106 tests of columns, 76 of which were made prior to July 1, 1918, and 30 during the half year ending December 31, 1918. During the latter period fire tests were conducted on 8 structural-steel columns protected by hollow clay tile or solid gypsum block, 1 unprotected cast-iron-pipe column, and on 6 timber columns, 4 of which were tested unprotected and 1 each protected by plaster on metal lath and by plaster board. Fire tests, followed by water application, were made on 15 columns, representative in type of section and method of protection of those tested in the main series.

*Purpose.*—The purpose of this investigation is to ascertain (1) the ultimate resistances against fire of protected and unprotected columns as used in the interior of buildings; (2) their resistance, when in a highly heated condition, against the impact and sudden cooling from hose streams.

While columns form the most important element in the strength of a building, few representative tests have been made to determine their ability to support loads when exposed to fire, and fire experience has only a limited value, due to many unknown variables involved. As a consequence, wide differences in requirements relating to the protection of columns against fire exist between different municipal codes and other published regulations. This investigation was undertaken to obtain information on which proper requirements for the various types of columns and protective coverings can be based.

*Scope of Tests.*—The fire-test series includes (1) tests of representative types of unprotected structural steel, cast iron, concrete-filled pipe, and timber columns; (2) tests wherein the metal was partly protected by filling the reentrant portions, or interior, of columns with concrete; (3) tests wherein the load-carrying elements of the columns were protected by 2-inch or 4-inch thicknesses of concrete, hollow clay tile, clay brick, gypsum block; as, also, single or double layer of metal lath and plaster; (4) reinforced-concrete columns with 2-inch integral concrete protection.

The covering materials for each class of protection were obtained from the main producing regions of the country, the object being to include samples from the principal types of materials that find general application in building construction. The column coverings were applied by experienced men in accordance with plans and specifications drawn to secure average results obtainable under ordinary commercial conditions. A large number of auxiliary tests of constituent materials were made, including several hundred compression tests on the concrete employed.

*Method of Testing.*—The test columns in this series were designed for a working load of approximately 100,000 pounds, as calculated according to accepted formulas, the amount varying somewhat for the different sections. This load was maintained constant on the column during the test, the efficiency of the column or its covering being determined by the length of time it withstood the combined load and fire exposure. The latter was produced by placing it in the chamber of a gas-fired furnace whose temperature rise was regulated to conform with a predetermined time-temperature relation. The temperatures of the furnace and of the test column were measured at several points with thermoelectric pyrometers, and the deformation of the column due to the load and the heat was measured on two opposite sides over a 37-inch (94 centimeter) gauge length.

In the fire and water tests the column was loaded and exposed to fire for a predetermined period, at the end of which the furnace doors were opened and a hose stream applied to the heated column, the duration of the application and pressure at the nozzle varying with the length of time the corresponding type of column withstood the regular fire tests.

*Summary of Results.*—Under the conditions of the fire test the columns sustained their loads for periods varying from 11 to 35 minutes for the unprotected steel, cast iron, and pipe columns to over eight hours for some of the heavier concrete protections and reinforced-concrete columns. This proves that unprotected columns are unsuitable for use in locations where fires are possible, and that adequate protection can be obtained by the use of moderate amounts of covering material, properly selected and applied. Large variations were found in the effectiveness of material within a given class, such as between protections of concrete made with different aggregates and of hollow tile from the different types of clay. The method of application was also a large factor in the result, particularly in the case of the protections applied in the form of units or blocks. Duplicate fire tests made with columns protected by coverings of the same material and design gave fairly consistent results, the maximum variation from the average value being within 10 per cent for the protections cast or poured in place and within 20 per cent for those built up of units or blocks.

No column failed in the fire-and-water test series, the principal effect of the fire-and-water application being to loosen or carry away more or less of the covering material.

The preparation of the test results for publication is now in an advanced stage.

### Strength of Metals at High Temperatures.

A brief description of an apparatus built for determining the compressive strength and elastic properties of materials as affected by heat was given in the last report. During the year a number of trial runs have been made to test out various details of the equipment and some initial tests completed on specimens of structural steel in the form of standard rolled shapes. These indicate that under constant load of 10,000 pounds per square inch failure occurs at about 575° C., and the limit of utility from the standpoint of further use as a structural member is reached at 500° C. Increasing the load to 20,000 pounds per square inch depresses both points very nearly 75° C.

The work is being continued and will include tests of cast iron, concrete, and timber.

## Pyrometer Lag.

With the types of pyrometers used for determining the temperatures in furnaces, and used in fire tests of building constructions, large errors due to the lag of the pyrometer with rising or falling temperatures are usually incurred. The lag is the difference between actual and indicated temperatures, and varies with the rate of temperature change and the type of mounting employed. In fire tests, the temperature rise of the furnace during the first part of the test is very rapid, duplicating in this respect conditions generally present in building fires. Inasmuch as some materials used in structural members and their protections sustain severe damage when subjected to rapid heating, it is important to be able to determine the actual temperatures present in given tests, and, from the point of standardization, to be able to produce a predetermined fire exposure with a given furnace and pyrometer equipment.

During the year a beginning has been made in developing methods for determining the lag constants of furnace pyrometers. The problem is complicated by the varying character of the heat influences to which they are subjected and the difficulties incident with their duplication in a calibrating furnace.

## Fire Tests of Concrete Columns.

In this investigation, 28 full-sized building columns of reinforced concrete have been made, 25 have been subjected to the combined fire-and-load test, and 7 have been tested cold, in compression, in the 10,000,000-pound testing machine.

The work done during the year has been twofold in nature, consisting of the making and testing of full-sized building columns of reinforced concrete from aggregates which had not previously been included and in making and testing columns with protective material other than concrete. It has been found that columns made from the so-called Cow Bay gravel—a mixed gravel containing a large proportion of granite pebbles and gneiss pebbles—and columns made from pure quartz gravel gave somewhat poorer results than columns from Pittsburgh gravel previously tested. In the later column tests the protective concrete spalled so badly early in the fire test that a large part of the protective covering, after breaking up into slabs, fell away from the column, exposing the steel and the load-bearing concrete to the fire. These columns failed, under their working load, before the completion of the four-hour fire test. Columns in which the coarse aggregate was trap rock showed no tendency to spall or to crack seriously in the fire tests and retained more than half their original strength as determined by load tests made while the columns were at maximum temperatures at the end of the four-hour fire test. The results shown by columns in which the coarse aggregate was blast-furnace slag were similar to those with the trap-rock aggregate.

*Experiments on Methods of Column Construction and Protection.*—Since it has been found that columns from gravels of three different types are much less reliable as to resistance to fire than columns of limestone, trap rock, or blast-furnace slag, an effort has been made to develop practical methods whereby columns from gravels of these types, which are in very extensive use, can be so protected as to resist fire, as well as, or better than, columns from the other aggregates without additional cost in construction. Columns have been cast in gypsum forms which were used to serve the double purpose of doing away with the somewhat excessive cost of steel or wood forms and of remaining in place to serve as protection against fire. Forms of this sort, with a light binder of expanded metal or of poultry netting, have been found to stay in place throughout the four-hour fire test and to afford excellent protection. Gravel-concrete columns so protected came through the four-hour fire test much better than trap rock and slag-concrete columns made in the usual way.

It has been found that columns could be made without the usual steel or wood forms by wrapping metal lath around the spiral reinforcing steel and casting the concrete in that. The results obtained indicate that no great difficulty should be experienced in making columns in this way if concrete of medium consistency is used.

*Protective Plasters.*—Several columns have been made and tested in which a part of the protective covering has been supplied in the form of plaster from Portland cement and sand. These columns gave better results than gravel-concrete columns from the same aggregate, made in the usual way, but not as good as those made from trap rock and slag in the usual way. The trouble with this form of protection is that the outer coat, or coats, of plaster fall off under fire conditions, leaving the column with insufficient protection.

Considerable work has been done in the study of plasters for the protection of gravel-concrete columns and for other purposes. It has been found that, within certain limits, mixtures of gypsum, hydrated lime, and kieselguhr give workable plasters of superior heat-insulating properties. One column which had been cast in expanded metal over spiral reinforcement was covered with approximately 1 inch of a mixture of these materials. Poultry netting was placed over the second coat and concealed by the third coat. A finish coat of gypsum and hydrated lime was used. In the fire test only the finish coat came off. The total thickness of protective material on this column was approximately 1½ inches, and the effectiveness of the thermal protection was such that the highest temperature measured in the steel was 185° C., as against 410° C. in the steel of columns protected by 2½ inches of material in the form of concrete covered by cement plaster.

**Fire Prevention.**

The section has cooperated, by conferences and correspondence, with Federal, State, and local agencies in matters relating to safety to life, fire protection, and fire prevention.

These conferences related to such matters as fire hazards in various industrial processes, such as cotton ginning, storage and shipment of fertilizers, storage and shipment of petroleum products, pyroxylin plastics, including motion-picture film, etc.

Complete inspections of the properties and occupancies of the Bureau of War Risk Insurance were made at the request of that bureau, and a report was rendered on the fire hazards involved, with especial reference to the safe storage of documents.

A member of the section has participated in committee work of the National Fire Protection Association, the Fire Marshals' Association, the National Safety Council, and other organizations interested in fire prevention and the reduction of fire waste. Considerable work has been done in cooperation with the first of these associations in matters relating to exits from buildings where large numbers of people are housed.

The section cooperated with a committee of the various branches of the War Department in the preparation of standardized specifications for fire extinguishing and signal apparatus and supplies.

## AUTOMOTIVE POWER PLANTS AND THE FUELS AND LUBRICANTS THEREFOR.

(Investigation of the fundamental, scientific, and technical problems related to the design and operation of internal-combustion engines and accessories, and the qualities and characteristics of fuels, lubricants, etc., for use in such engines.)

During the first half of the year the work was limited to the immediate necessities of the military departments of the Government and was confined to specific questions of the performance of particular engines and accessories, fuels, lubricants, etc. While carrying out these tests data were obtained which were known to have important bearing on the more fundamental questions relating to internal-combustion engines and which are generally conceded to be of great importance in the economic development of the automotive industry of the country.

When the signing of the armistice afforded relief from the pressure of hurried tests and tentative analyses, the facilities of the laboratory and the time of the staff were turned toward the fundamental questions and the review of the data obtained earlier as a by-product. The topics described below, therefore, parallel very closely the ones listed under this subject in the previous annual report. The advance to be recorded is the marked progress in correlation of the work and its reduction to a form in which the results are available to the automotive industry.

### Ignition.

A comprehensive investigation of spark plugs and ignition appliances, commenced in 1916, has been continued, and the results so far attained have been communicated to manufacturers and users of such apparatus, who have shown most gratifying appreciation. The printed reports will shortly be available to the general public in the fourth annual report of the National Advisory Committee for Aeronautics, under whose auspices most of the investigational work was conducted by this section, with the active cooperation of the electrical and ceramics divisions of the Bureau. These reports, seven in number, are entitled "Spark Plug Defects and Tests," "Properties and Preparation of Ceramic Insulators for Spark Plugs," "Effect of Pressure and Temperature on the Sparking Voltage," "Heat Energy of Various Ignition Sparks," "Temperature in Spark Plugs Having Brass and Steel Shells," "The Subsidiary Gap as a Means for Improving Ignition," "Characteristics of High-Tension Magnetos." Each one of these reports is made up of several small reports dealing with a particular phase of the general investigation.

An investigation of the properties of insulating cables in ignition systems was completed. A comprehensive series of oscillograph photographs of magneto-wave forms was obtained and is available for inspection, but not for reproduction and general distribution.

### Radiators.

The experimental work of the past two years, conducted largely under the auspices of the National Advisory Committee for Aeronautics, has been compiled in seven reports, which will shortly be available to the public in the fourth annual report of that committee, under the following titles: "Synopsis of Aeronautic Radiator Investigations for 1917–18"; "General Analysis of Radiator Problems"; "General Discussion of Test Methods for Radiators"; "Head Resistance Due to Radiators"; "Effects of Altitude on Radiator Performance"; "Results of Tests on Radiators for Aircraft Engines"; "Some Problems of Radiation," each of which deals with a number of specific problems in this particular line.

The laboratory measurements have been completed on flat-plate radiators, fin and tube radiators, and whistling radiators. The effect of yaw on head resistance and heat dissipation has been studied. An analysis of the best proportions in radiator design to accomplish specified results is in progress. This will enable manufacturers to apply directly the results of two years of scientific work relating to the most important features of radiator design and construction.

Much experimental work is still in progress to determine more completely such fundamental data as pressure drop of the air through different types of radiator tubes, temperature distributions, measurement of mass flow of air, etc. Theoretical investigations are under way relating to air-cooled engine cylinders and to increased radiator requirements imposed by the use of superchargers on aircraft engines.

### Altitude Laboratory.

The Bureau has the only "altitude laboratory" constructed to date in this country. This is a small room with reinforced-concrete walls strong enough to withstand the pressure produced on the outside by exhausting the air within to a pressure as low as one-third atmosphere. The engine under test is mounted on a suitable stand within this chamber. The air supplied the engine at these low pressures is also cooled in order to reproduce as closely as possible atmospheric conditions existing at high altitudes. Aviation engines have been operated in this chamber simulating flight at over 30,000 feet, but under conditions permitting of careful scientific measurements. Comprehensive tests were made of the performance of sample engines in advance of quantity production for the purpose of selecting suitable manifolds, carbureters, etc., with respect to performance under flight conditions. Information obtained in such tests had an important bearing on the selection of the equipment for the Hispano-Suiza, type E, aircraft engine. A careful study was made of the performance, under altitude conditions, of the well-known "Liberty 12" engine. A description of this laboratory and the more general results obtained in it have been collected in a series of four reports which are being published by the National Advisory Committee for Aeronautics in their fourth annual report under the following titles: "Effect of Compression Ratio, Pressure, and Temperature on Power"; "A Study of Airplane-Engine Tests"; "Power Characteristics of Fuels for Aircraft Engines"; and "Description of Altitude Laboratory."

The hastily constructed altitude chamber, housed in a temporary stucco shed, which met the immediate needs of the military work, is being replaced with a better-designed chamber in a permanent brick structure. Provision has been made in this laboratory for equipment which will be available for work of interest to the automotive industry of the country. The constructional work on this building is now nearing completion, but the equipment is not fully installed.

### Flame Propagation in a Gas-Engine Cylinder.

A method for the measurement of the rate at which the flame is propagated in an engine cylinder while operating under service conditions has been developed in cooperation with the electrical division of the Bureau and has proved successful. The preliminary results obtained by this method of measurement indicate a speed of propagation less than that commonly assumed by designing engineers, and the final results, when available, will have an important bearing on engine design.

### Pressure Cycles Occurring in Gasoline Engines.

Indicators for the measurement of the pressures in heavy, slow-speed engines prove useless on the light, high-speed engines for aircraft, because of inertia of their moving parts. Two new indicators are being developed with much promise of success. The successful development of an indicator suitable for use at high speeds will provide a most useful instrument in the development of high-speed, internal-combustion engines.

### Carburetion.

This work is part of an extended program, including the fundamental physical questions concerning vaporization and atomization of fuels in carbureters, engine manifolds, and cylinders; apparatus has been designed, constructed, and used for the purpose of studying the metering characteristics of both airplane and automobile carbureters as affected by barometric pressure, rates of air flow, air temperature, engine speed, etc. With a view to the determination of the fundamental principles of operation, an investigation has been made of the relative performance of various methods for the automatic and inherent compensation for changes in metering characteristics with change in barometric pressure; that is, altitude.

Two papers collecting results of this experimental work have been completed and transmitted to the National Advisory Committee for Aeronautics for publication in their fourth annual report under the titles, "Carbureting Conditions Characteristic of Aircraft Engines"; "Metering Characteristics of Carbureters."

### Effect of Water Injection on Gas-Engine Performance.

An extensive although still incomplete series of experiments on this subject has been made. The results so far obtained show no appreciable gain in power or energy with water injection. The report of these experiments has been communicated to the National Advisory Committee for Aeronautics, which will publish it in their fourth annual report.

### Tests of Special Engines and Accessories.

Numerous special tests were conducted during the year, including one on a small, direct-injection, Marburg, heavy fuel engine, a "barrel" type engine, and a special 16-valve-head Ford engine, and two battery-charging sets, tested for the Signal Corps for reliability.

A specially designed mercury-cooled exhaust valve has been found very successful in a Hispano-Suiza aircraft engine and will help to solve a problem of special importance in an engine of this type.

### Petroleum Conservation.

From the beginning of the war the work of the Bureau of Mines on automotive-fuel conservation was actively supported by the Bureau of Standards through close and constant cooperation. At the meeting of the Interallied Commission on Specifications for Petroleum Products of the Interallied Petroleum Conference some of the delegates from our Allies urged a very rigid gasoline specification for fuels for use in combat aircraft, basing their recommendations on their own satisfactory experience with certain gasolines, but without full knowledge of the possible performance of other gasolines. The adoption of such close specifications would have materially reduced the available supply of combat aviation gasoline and introduced unnecessary expense and serious difficulty, not only in production but in overseas shipment and distribution. A careful comparison of the power-producing qualities of 10 different gasolines selected through cooperation with the Bureau of Mines was made by actual engine tests under flight conditions in the altitude laboratory of the Bureau. A report on these tests was the only quantitative data presented to the Interallied Commission on this subject, and it resulted in the adoption of more liberal gasoline specifications, which were amply justified in service and which resulted in a saving to the American people of millions of gallons of oil in their fields and thousands of dollars waste effort in the refining and distribution in France of aviation gasoline.

### Fuel Comparisons, Fuel Savers, and Kerosene-Burning Devices.

In addition to service tests on common and aviation gasolines a number of synthetic fuels were tested at the request of the Bureau of Mines and the Navy Department, respectively. Reports were prepared on the performance of "Hector" fuel, a mixture of 70 per cent cyclohexane and 30 per cent benzol developed by the Bureau of Mines, and "Alcogas," a fuel containing a large percentage of alcohol. The general conclusions from these tests will be compiled for publication. Five proprietary preparations intended to be used as gasoline substitutes were tested for the military service. Many of the so-called "gasoline improvers" were tested for the Inventions Section of the General Staff of the Army. Two devices for the convenient use of kerosene instead of gasoline in the usual gasoline engine have also been tested for this section.

### Lubrication.

The work on the general subject of lubrication has been carried on under the supervision of an oil committee representative of the Automotive Power Plants Section, the miscellaneous materials section, and the Chemistry Division.

### Lubrication of Internal-Combustion Engines.

Prompted by the desire of overcoming lubrication difficulties experienced in airplane engines, the Bureau of Aircraft Production initiated at the Bureau of Standards a thoroughgoing investigation of lubricating problems. A complete program was drawn up to cover the entire complex situation to be investigated and a new laboratory was equipped for the purpose. The work done in this laboratory up to the end of the fiscal year has been confined largely to apparatus design. Some of the investigations planned have been begun, but no completed results can be reported.

The following apparatus necessary partly for routine tests and partly for new investigations has been completed and is now in use: Oxidation oven for commercializing the Waters' oxidation test; Herschel emulsifier for making demulsibility tests; apparatus for measuring gasoline absorption; battery of Saybolt viscosimeters provided with electric heating and thermostatic temperature control; vacuum-distillation apparatus for lubricating oils.

### Standardization of Instruments.

In continuation of the work of viscosimeter comparisons, the Ubbelohde viscosimeter has been investigated and the viscosity of various samples of gasoline determined. This work is described in Technologic Paper No. 125. The Redwood viscosimeter is now under investigation.

The Bureau's report on the "Tag" closed flash-point tester was published by the American Society for Testing Materials, as an appendix to the report of the committee on preservative coatings for structural materials, and was presented at the annual meeting of the society, June 24–27, 1919.

### Friction Machine.

Considerable work has been done to determine the relation between viscosity and friction and the conditions necessary to obtain reliable results with friction machines. This work is being continued. A new friction machine for the particular purpose of studying the lubrication problems arising in connection with internal-combustion engines has been completely designed and is in process of construction.

### Routine Physical and Chemical Tests.

The ordinary physical and chemical tests of lubricating oils, consisting chiefly of the determination of the viscosity, flash point, fire point, pour point, demulsibility, acidity, percentage of fat, and percentage of ash, have been made according to generally accepted methods on many samples submitted by Government departments. Oils for internal-combustion engines and for other special uses were also tested by Conradson's method for carbon residue, as well as by the Waters' method for the carbonization value. The latter method was developed at the Bureau.

During the year physical tests were made of 529 samples of lubricants and chemical tests of 557 samples.

## 4. LIGHT AND OPTICAL INSTRUMENTS.

**[Spectral analyses; measurements of standard wave lengths; aerial photography; standards and testing of sugar and other materials by optical means; general polarimetry; color measurement and specification of color standards; spectral transmission and reflection of dyes and other materials; design and testing of optical instruments; testing of optical glass; radiometry; investigation of dispersoids; interferometry.]**

### SPECTROSCOPY.

**(Spectroscopic investigations of metals, rare earths, and rare gases; red and infra-red investigations of the atmospheres of the sun and the earth; development of infra-red photography for aerial observations.)**

#### Red and Infra-Red Spectra of Chemical Elements.

The principal work of the spectroscopic laboratory is the determination of standards of wave length in the spectra of the chemical elements. Because of its experience in the use of photographic plates sensitized to red and infra-red light, it has devoted considerable attention to the investigation of these long wave regions of the spectra of the chemical elements. Although the greater portion of the time and energy was devoted to war problems described below, yet considerable progress was made in spectroscopic research. The investigations of the red and infra-red spectra of silicon, titanium, vanadium, chromium, manganese, molybdenum, tungsten, and uranium reported last year as being in progress are now completed, and the data have been collected for publication. Similar studies of the rare gases krypton and xenon have been completed and are now in press. The investigations of zinc, cadmium, mercury, aluminum, tin, lead, antimony, bismuth, silver, and gold are nearing completion, and investigations of the rare-earth elements yttrium, lanthanum, cerium, samarium, thorium, erbium, etc., have been started.

#### Applications to Astrophysics.

The study of the red and infra-red spectrum of the sun mentioned in the last annual report has been completed. Additional spectrograms on plates bathed with pinacyanol and dicyanin have been secured with the Porter spectrograph of the Allegheny Observatory. These plates have been measured and reduced and the results are now in process of publication. Briefly, it has been found that in the portion of the sun's spectrum comprised between the limits 6,500A and 9,000A there are more than 2,400 Fraunhofer lines. Of these nearly 60 per cent are produced by the earth's atmosphere, the remainder being of solar origin. Over 500 of the 900 lines due to absorption in the sun's atmosphere indicate the presence of 27 chemical elements whose spectra have been investigated in the red and infra-red regions.

#### Spectroscopic Analyses.

Spectroscopic analysis affords a rapid and accurate method of examining minerals, ores, metals, alloys, and various compounds for which a qualitative analysis is desired. In some cases it is also possible to make quantitative analyses as well. During the year the following substances have been analyzed spectroscopically: Five samples of tungstic oxide, smokeless gunpowder of German and American manufacture, five samples of ores containing zirconium, six samples of barium chloride, two samples of gallium, two of tin, and one of very pure magnesium wire. In addition to the above substances, whose arc or spark spectra were photographed for purposes of analysis, low-pressure tubes containing samples of "C" gas used in filling dirigible airships were made and their spectra examined. This gas was found to be chiefly helium contaminated with air.

### False Spectra Produced by Gratings.

In the course of the investigations on the infra-red spectra of various metals it was noted that many lines of apparent wave length greater than 10,000A corresponded to lines of shorter wave length in the visible red region of the spectrum. The ratios of the wave lengths of the visible red lines to the corresponding lines in the infra-red region were found to be constant and to be of four values; that is, each line produces at least four false lines or "ghosts" at remote distances from the exciting lines. The existence of "ghosts" near the exciting lines and of the remote ones discovered by Lyman in the ultra-violet has been known for some years. These discovered in the infra-red may be of the Lyman type, but if so are due to a ruling error different from that in the grating used by Lyman. Their presence has made it desirable to study the imperfections of diffraction gratings, and accordingly the Bureau has borrowed a number of gratings ruled at the Johns Hopkins University for the purpose of studying the nature and causes of the false spectra given by them.

### Low-Pressure Tubes for Spectroscopy.

The spectra of gases are studied by passing an electric discharge through a tube containing the gases at low pressure. Frequent requests come to the Bureau to supply tubes for use in astronomical and physical investigations. During the year 38 tubes have been filled with oxygen, hydrogen, helium, neon, and mercury. Attention is called to the fact that the helium used for this purpose was obtained from the gas wells in the western part of this country, from which helium is taken for use in dirigibles. The helium as used in the dirigibles is contaminated with impurities which are removed when a tube is prepared for spectroscopic work.

### Spectroscopic and Optical Apparatus.

The spectroscopic laboratory has during the year produced some apparatus of various types to meet its own needs and the needs of others who have come to it for assistance. To facilitate the securing of spectrograms a new arc stand was designed and constructed and also a new plate holder.

For qualitative work in the study of low-pressure tubes, flames, arcs, etc., a new direct-vision spectroscope has been designed, using glasses made by the Bureau of Standards. Also a large number of replica gratings have been made for the same purpose. These have been supplied to various Government laboratories, which have found them useful in qualitative work.

A photographic lens corrected for red light has also been computed. This lens is in process of construction at present in the optical shops of the Bureau.

### Aerial Photography.

It is well known that the ordinary photographic plate when exposed in a camera does not reproduce exactly what the eye sees. This is because the ordinary plate is affected by only blue and violet light, for which the eye is relatively insensitive, and is scarcely at all affected by the green and yellow, for which the eye has its maximum sensitivity. These ordinary photographic plates are practically insensitive to red light and are therefore handled with safety in light from a ruby lamp. It has long been known, however, that photographic plates may be made sensitive to green, yellow, and red light by the admixture of suitable dyes to the emulsions on the plates.

A plate sensitive to these longer waves possesses some marked advantages over the blue and violet sensitive plate. A panchromatic plate reproduces more faithfully what the eye sees, and when exposed behind a ray filter or color screen it portrays objects which, on account of haze, smoke, etc., would be hidden from an ordinary plate and also gives different contrasts, depending on the nature of the light transmitted to the plate through the filter. The phenomenon of haze penetration by the longer waves is known to most outdoor photographers. Not only haze due to water vapor, but smoke haze, which looks bluish to the eye, is largely eliminated by using light of longer wave length than that which is most effective in case an ordinary unscreened plate is used. Objects completely obscured on an ordinary unscreened plate by haze or smoke may be shown in good detail by using a panchromatic plate and a red filter. Such red sensitive plates, of course, can not be handled in the presence of the well-known dark-room ruby lamp, but must be developed in complete darkness or in a very weak green light. To obtain the long-wave advantages of haze penetration and contrast mentioned above the photographic plates must have the greatest possible sensitiveness to yellow, orange, and red light if the exposure times are necessarily short on account of rapidly moving objects or if the camera itself is in rapid motion, as is the case in aerial photography. When corrected camera lenses giving very bright images are not to be had it is even more necessary that the photographic plates be of the highest possible sensitiveness.

During the war aerial observation early came to play a prominent part, and it became a matter of great importance to have a suitable panchromatic plate for aerial photography. Laboratories and research organizations in various allied countries were busily engaged in trying to produce plates of extreme sensitiveness or speed. The best commercial orthochromatic (sensitive to blue, green, and yellow) and panchromatic (sensitive to all colors) plates were too slow for most purposes. For many years, however, physicists had used yellow and red-sensitive plates which greatly exceeded in speed any of the commercial plates. These plates are prepared by bathing an ordinary photographic plate (sensitive to violet and blue) in certain solutions of aniline dyes, and at the expense of keeping qualities such plates may be made much more sensitive to red light than any plate known to commerce. After several years of experience with such plates in spectroscopic investigations by the Bureau of Standards, it seemed worth while, when the United States declared war upon Germany, to make an application of them to landscape photography. Accordingly, experiments were made in 1917 to determine the practicability of using the bathed plates for landscape photography, with the hope that either this method might be a useful addition to the photographic methods of our military forces or that the experiments would lead to improved commercial plates which incorporate sensitizing dyes in the photographic emulsions.

Preliminary tests with apparatus that was inadequate to test the real merit of the bathed plate proved encouraging enough to warrant a continuation of the investigation with better apparatus (more suitable cameras and ray filters), and with new dyes of British manufacture.

The attention of the Science and Research Division of the Signal Corps was attracted to these early results and the Bureau of Standards was given the opportunity of comparing the stained plates with various plates used by the military forces. Among these were several types of British-made panchromatic plates then in use on the western front for aerial photography. A series of experiments soon showed that pinacyanol stained plates were at least four times as fast as the best commercial panchromatic plates then in use. In particular, plates stained with some new dyes of British manufacture were found to be much superior to any commercial panchromatic plates not only in speed, but also in the range of color sensitiveness.

These encouraging results led to the offer of the Bureau of Standards to supplement the photographic work of our military Air Service by adding to it a new method which would probably be of great military importance in special photographic work, such as the penetration of haze and smoke, detection of camouflage, etc., where the ordinary commercial plates could not be satisfactorily used. The assurance of cooperation from the War Department was received and the Bureau invited by the Signal Corps to test the bathed plates in aerial photography as soon as facilities permitted. Extensive experiments were made at Langley Field during the spring and summer of 1918 under the generous auspices of the Science and Research Division of the Signal Corps, and after the armistice was signed the flying facilities of Bolling Field were used to a limited extent to complete the experiments.

Early in 1918 a representative of the spectroscopic section of the Bureau of Standards who was in France was requested by the French military authorities to assist the French photographic section in making fast-color sensitive plates. A temporary laboratory was installed similar to the ones at the Bureau of Standards, with the exception that the plate-drying cabinet was arranged so as to use air heated by a gasoline stove. This was necessary on account of the low temperature and high humidity prevailing in northern France in winter. The following experiments with bathed plates were made there: Ordinary fast plates were stained with pinaverdol and pinacyanol with ammonia; orthochromatic plates were bathed in pinacyanol with ammonia; panchromatic plates were bathed in ammonia. Each type of plate was used in three ways—unscreened, with a deep yellow screen, and with a red screen. The bathed plates were found to be somewhat faster unscreened than any plate actually used by the French. Using screens, the bathed plates were shown to be much faster, particularly for red photography. This matter was also considered of very great importance by the American Aviation Section, and it was requested that one of our physicists cooperate with them on experiments of this kind. This cooperation was offered, but was not strongly supported by the military authorities in this country, largely on account of the fixed idea that bathed plates had only reached the experimental stage. Considering the special equipment and technique required by such plates, their use at the battle front was held in abeyance, with the hope that commercial panchromatic plates of sufficient speed would be forthcoming.

The success with which dye-sensitized photographic plates had been used in the laboratories of the Bureau convinced this section of the possibility of their being of extreme importance in special military applications and impelled the Bureau to demonstrate their value by careful measurements in the laboratory and tests in the field. In addition to the problems of ordinary photography the use of bathed plates with light filters involved, (1) a study of photosensitizing dyes and of the spectral sensitivity which they imparted to ordinary photographic plates, (2) experiments still further to increase the speed of color-sensitive plates, (3) investigations of the spectral distribution of energy reflected from landscape, etc., (4) design and construction of new photographic lenses for use with red light, and other similar problems. A detailed report of this work was made under the title of "Photographic researches."

### Hypersensitizing Commercial Panchromatic Plates.

The speed and color sensitiveness of photographic plates are of extreme importance in military photography to obtain results under unfavorable conditions of light intensity, haze, relatively low-speed cameras, etc. It is, therefore, obvious that a commercial panchromatic plate with good keeping qualities is, if sufficiently fast, more economical than a stained plate. The cause of the superior speed of the stained plate, perhaps, lies in the use of ammonia in the staining bath. It became, therefore, a matter of interest to see to what extent commercial panchromatic plates could be hypersensitized by treatment with ammonia. Experiments showed that ammonia increased the speed of various brands of panchromatic plates from two to four times and also extended the sensitiveness to considerably longer waves. The treatment consists in soaking the plate prior to using, for four minutes in a bath containing 75 cubic centimeters water, 25 cubic centimeters ethyl alcohol, and 3 to 4 cubic centimeters of strong ammonia. Plates so treated have been used successfully in aerial photography, and also for spectroscopic work in various scientific laboratories and astronomical observatories.

### Dyes for Photographic Sensitizing.

Ordinary photographic plates, which owe their sensitiveness to the silver halides alone, are sensitive only to the blue, violet, and ultra-violet regions of the spectrum. If, however, a suitable dyestuff be added, the emulsion becomes sensitive to other regions, the particular region depending on the dye used. The dyestuff is applied to the halides in one of two ways: In the commercial orthochromatic and panchromatic plates the dyes are incorporated in the emulsion and the mixture is flowed over the glass plate. The second method consists of bathing an ordinary blue-sensitive plate in a dilute solution of the dye and allowing the plate to dry. The dyes most valuable for sensitizing photographic plates to the longer wave portions of the spectrum are commonly known as pinaverdol, pinacyanol, and dicyanin. Pinaverdol sensitizes a blue and violet sensitive plate to the green part of the spectrum; pinacyanol sensitizes from green to red; and dicyanin is most efficient in photography of the red and infra-red spectrum.

Previous to the war practically all of the dyes which were most successfully used in photographic sensitizing were produced in the large dye factories in Germany. When this source of supply was cut off, not only was the commercial color-sensitive plate manufacturer put to some trouble to find substitutes for the dyes he formerly imported, but the physicist also, who prepared bathed plates for special problems, seemed likely to have to discontinue his work because of the shortage of dyestuffs.

*Photographic Dye.*—The spectroscopy section of the Bureau of Standards had been making extensive use of photographic dyes in spectroscopic work during the past five years, and attention was called at the beginning of the European war to the importance of making such dyes in America. Upon the entrance of our country in the war the urgency of work on photosensitizing dyes was insisted upon, and this work was earnestly undertaken by the chemical division of the Bureau of Standards and by the Bureau of Chemistry of the Department of Agriculture. The spectroscopy section of the Bureau of Standards maintained close relations with this work and cooperated by testing the photosensitizing properties of all the samples of dyes submitted for this purpose. During the past year nearly 100 different samples of such dyes were tested, and many of them were found equal or superior to their foreign predecessors in usefulness for photography. Quite aside from the importance of such excellent photosensitizing dyes for use in military photography their value in spectroscopic and astronomical researches of the future can not be overestimated.

## POLARIMETRY.

**(Standardization of materials, including sugars, sirups, and other compounds, by polarimetric methods; precision polarimetry, including the determination of polarimetric constants; development of standard definitions, methods, and instruments; calibration of polarimetric apparatus; standardization of the technology of sugars and related materials; research in all factors affecting the efficient organization of sugar manufacture and testing; sugar standards for precision-calibration purposes; laws and principles of magneto-optics and their practical application.)**

### The Rare Sugars.

There are now known and are being used by the Medical Service of the War Department and the general public about 20 of the so-called rare sugars. The demand for a highly purified dextrose (glucose) has become so great that its production has increased to a point where it can no longer be designated as a rare sugar, but must be placed in the same category with ordinary sugar (sucrose).

Unfortunately, there is in existence but little scientific data on the rare sugars, and practically all there is is inaccurate and wholly inadequate for modern usage. Many of these sugars undoubtedly have valuable properties unknown at this time. One of their principal uses is the differentiation of bacteria, for which purpose they are invaluable.

During the year the Bureau has had presented for test a number of these rare sugars. Necessarily, their investigation requires careful research, so that progress is slow. The demands on the Bureau for this work are so insistent and continuous that plans have been drawn for a section wholly devoted to the scientific exploration of this important field. The sugars are nearly all expensive to produce; their current values ranging from a few dollars to $350 a pound. A number of them might have great commercial importance if they could be produced at a reasonable cost. The results which the Bureau has attained in this work during the past few months are most encouraging.

### Production of d-Mannite.

At the request of the War Department, the Bureau has undertaken the production of a considerable quantity of d-Mannite. This little-known sugar is utilized on an extensive scale by the Army Medical Service. The source of supply is a crude manna. The Bureau's investigation finally developed a method whereby pure white crystals of d-Mannite can be produced by two crystallizations from the crude manna. It thus became possible to produce relatively large quantities of the valuable substance at a reasonable cost. The Bureau is now engaged in this work and will produce 1,000 pounds of the pure material.

### A New Fixed Point on the High-Temperature Scale.

The successful termination of a scientific research, no matter what its character, almost invariably leads to an extension of knowledge in other directions than those contemplated within the scope of the original problem.

The investigation of the natural rotation of light by crystalline quartz at high temperatures has developed new and unexpected phenomena. Additional knowledge of the properties of quartz is of importance from the theoretical standpoint because of its extensive use in polarimeters and other instruments, and because of its relation to problems involved in the study of the history and the formation of the earth.

At a temperature of about 573° C. crystalline quartz changes into another crystal, with a transformation of energy during the process. The discovery made by the Bureau is that the temperature at which the transformation starts when the crystal is being heated is a very definite and sharply defined one. A careful investigation has shown this point to be 573°.3 C. The transformation of energy at this temperature is apparently far sharper and more easily determined than that utilized in determining the ordinary points on the high-temperature scale. It is found that a thermocouple close to but not actually in contact with a small plate of quartz will record this point with high precision. To obtain the best results the thermocouple should be inserted in a small opening in the crystal, thereby standardizing it at a fixed and accurately known temperature. A study of quartz from various geograpically widely distributed sources shows that the phenomenon is common to all crystalline quartz. Also the temperature of 573°.3 C. is a fortunate one in that there is now in existence no known method of conveniently calibrating temperature-measuring devices in this region. Not the least important advantage is the ease with which a thermocouple can be standardized by the use of this method.

### Natural Rotation of Quartz at High Temperature.

The investigation of the natural rotation of light by crystalline quartz at high temperatures has been continued. As the temperature of a crystal of quartz approaches 573° C. there occurs a most profound change in all the physical properties of the crystal. It has been found that there is an especially abrupt change in the optical properties. When light, vibrating in a single plane, is passed through the crystal, the rotation of the plane of vibration which ordinarily occurs in crystalline quartz is found to suffer an abrupt change as the temperature of 573° is approached, the magnitude of the change depending on the wave length or color of the light used. When a curve is plotted, showing the variation of the rotation with the temperature, it is found that above 573°.3 C. there is comparatively little change in the rotation for relatively large changes in temperature. The Bureau's recent work has found that the curve expressing this property is a straight line almost parallel with the temperature axis from the inversion point of 573°.3 to 1,500° C.

The new work has also developed the law that the relative change in the rotation is practically the same, no matter what may be the color of the light passed through the quartz crystal. The so-called rotation dispersion of quartz has therefore been proved to be the same for all wave lengths at all temperatures up to the inversion point. As stated in last year's report, the Bureau's polarimetric measurements are the first precision measurements ever made at high temperatures. The progress made in these studies during the past year has made definite a new line of attack for many unsolved problems.

**Adjustment and Standardization of Polariscopes.**

The Bureau has inaugurated the work of adjusting polariscopes in addition to that incident to their standardization. This has become necessary owing to the fact that the sugar industry, as well as educational and research institutions, have been unable for some time to obtain new polariscopes or to get those that they have, which are out of order, put in serviceable condition.

Owing to the sudden expansion in the sugar industry, it became necessary by war conditions to resort to the use of discarded instruments. Many of these instruments have a different basis of calibration from those of the newer and recognized types. The Bureau has constantly been consulted in regard to the use of these instruments and has been able to render an important service in this respect.

In addition to the above-mentioned class of instruments, a second class has been brought out of retirement. The latter are of recognized types and are excellent instruments for the manufacturers' and refiners' use. They are, however, useless to them owing to the fact that the optical parts are out of adjustment. In many instances it is found that nicols need recementing or need to be ground and polished or cemented in their sleeves; quartz wedges are often out of alignment or pressure may have developed on the wedges, etc. An instrument which has developed any of these defects is necessarily rendered useless until they have been corrected.

During the year the Bureau has adjusted and standardized 39 polariscopes, thus putting them in condition to render good service. To bring about this desirable end required considerable preliminary study and experimental work. The middle of the fiscal year had, therefore, arrived before the Bureau was ready to receive instruments in these classes. However, the preliminary work was so successful that 39 instruments were all handled in the latter half of the year. The scales of all polariscopes that have been sent to the Bureau have been calibrated and certificates have been issued, based on the now widely accepted Bureau of Standards' determination of the international sugar scale.

### Testing of Quartz Control Plates.

Quartz control plates are indispensable for the accurate daily checking of saccharimeters. Eleven of these plates were tested and certified for various sugar companies. Four, which were improperly mounted in wax, were removed from their original mounts and remounted in loose metal holders in such a way as to comply with the Bureau's specifications.

Owing to the fact that all quartz control plates have heretofore been imported from Europe, it has been impossible to secure any for some time. With the idea of being of the greatest possible assistance to the sugar industry in this emergency, the Bureau has abandoned its previous practice, and whenever feasible, is remounting and testing discarded or improperly mounted plates in a manner to make them serviceable. The values of a number of the Bureau's standard plates have been redetermined and found to be in good agreement with the values previously assigned them.

### Evaluation of the Clerget Constant.

Sugar, in every stage of its manufacture except the final one, occurs in combination with other optically active substances; that is, substances which affect the polariscope in the same manner as sugar itself. Therefore, from a single observation on the polariscope, it is impossible to estimate the percentage of sugar. If, however, the polariscope effect or rotation of the impurities is maintained constant, and the sugar is converted into other sugars (invert sugar) by the action of acid, the change of rotation is a measure of the quantity of sugar present. Thus the magnitude of this change of rotation when pure sugar is used is of fundamental importance and the value is known as the Clerget constant. The value of the constant which is now in general use throughout the world is 142.66—that is 100—the rotation of sugar, plus 32.66, the rotation of invert sugar, plus 10, a temperature correction.

During the previous year, the velocity of inversion was determined and it was found that the time which the sugar was exposed in the prevailing methods to the action of acid was excessive. The data obtained in this work made it possible to measure, under the proper conditions of time and temperature, the value of the Clerget constant. The rotation of invert sugar was found to be 33.25, instead of 32.66. This error of nearly 2 per cent affects the value of the total constant by one-half per cent and has appeared in analyses for the past 30 years.

The research has also shown that many other sources of error may be eliminated. These errors are caused by lack of constancy of the nonsugars. Three general methods of analysis have been proposed—one applicable to all substances, one applicable to beet products which are free from invert sugar, and one applicable to cane products. The value of the Clerget constant has been correlated with acid of varying strengths and with neutral salts formed by neutralization of the acids.

### Solubility of Sugar and the Causes of Molasses Formation.

The greatly increased solubility of sugar in the presence of salts results in the formation of molasses, from which no granulated sugar may be obtained by crystallization. At every stage of the manufacture the crystallization is affected by the presence of salts. The study of these solubilities is therefore of technical and scientific importance.

During the past year experiments have been made on the relative effects of sodium and potassium salts in high concentration on the solubility of sugar. These two metals predominate in the products of the sugar industry. The results have shown quantitatively the great influence which the presence of the salts exerts.

In continuing the research experiments will be made on the effect of increased temperature and of a great variety of inorganic impurities which occur in beet and cane juices.

### Proposed Change in the Normal Sugar Weight.

During the past year a movement has been started by American sugar chemists to change the normal weight of sugar from the 26 grams, which is now in nearly general use throughout the world, to 20 grams. If this new basis is adopted, the investigation started in the previous year on the change of rotation of sugar in altered concentrations becomes of pressing importance. Some measurements have already been made, and, in response to a general request from sugar analysts, the restandardization is being carried out as rapidly as possible.

### One Hundred-Degree Point of the Saccharimeter Scale.

During the past year the Bureau has been standardizing all saccharimeters to conform to the new value of the 100-degree sugar point which was discussed in the previous report. The investigation on this subject in the Bureau disclosed an error of over one-tenth of a per cent. Considering the precision with which the modern saccharimeter is used, this error is relatively a very large one and represents a very large sum of money in the buying and selling of sugars, as well as in the collection of the revenue on imported sugars. The previously accepted determination of the 100-degree point was made at the Sugar Institute in Berlin.

International agreement on this constant is a matter of great importance, and the Bureau delayed correcting the existing error in standardizing the saccharimeters and control plates submitted for test until it seemed almost hopeless to secure such international agreement in the near future. Saccharimeters standardized according to the new value have been giving excellent results and have been thoroughly satisfactory. Many industrial concerns have sent apparatus to the Bureau to be standardized merely to get their equipment on a correct scientific basis.

### Tested Supplies for United States Customs Laboratories.

The abnormally heavy importations of sugar and molasses during the past year have again emphasized the necessity of having reserve supplies of all standard apparatus used in the customs laboratories available. The situation relative to these supplies has been a most difficult one, owing to the unusual demands for additional equipment and owing to the difficulty in securing suitable supplies from the manufacturers. A customs laboratory is likely to require additional equipment at any moment. It is not feasible for each laboratory to carry sufficient reserve stock of all supplies that might be needed. The delay incidental to their purchase and the delivery by the manufacturer and the time necessary to standardize at the Bureau are often embarrassing. The most logical solution of the difficulty seems to be a storeroom at the Bureau in which tested supplies for the Customs Service can be held in reserve and shipped at a few hours' notice, as needed. Preliminary steps have been taken to bring this about.

### Customs Laboratory at Boston.

When the construction of a new building for the United States Appraiser of Merchandise at Boston was authorized, advantage was taken of the opportunity to provide suitable quarters for the installation of a modern customs laboratory. The Bureau was called upon by the Supervising Architect's office to draw up plans for this laboratory. It was therefore possible to arrange a distribution of space which was far superior to what could have been done had the installation taken place in a building already constructed. Advantage was taken of the opportunity to make the laboratory a model of its kind, with all new, modern equipment. It has now been in operation for several months and has proven satisfactory in every respect.

### Supervision of Customs Laboratories of the Treasury Department.

For several years the volume of work which the sugar laboratories of the Customs Service have been called upon to perform has been steadily increasing. This has occurred in the face of continuously decreasing importations of other commodities. The importations for domestic consumption during the past year have been the heaviest on record. In addition, Europe has been, to a great extent, supplied with sugar from Cuba and the West Indies which was purchased under an arrangement whereby it was to be refined in the United States. Since there is no provision in law whereby sugar can be imported into the United States and refined in bond with the object of exporting the finished product, it has been necessary to collect revenue on all the raw sugars destined for Europe. It has therefore been necessary to resort to every possible means in this emergency to increase the amount of testing done. Fortunately, this desirable result has been accomplished without perceptible deterioration in the quality of the work. The percentage accuracy of the tests has been successfully maintained at the prewar basis.

Considerable quantities of important new equipment have been added to the customs laboratories, and the work of assisting the Treasury Department in improving the personnel and efficiency has been continued.

### Pure Sugars for Miscellaneous Purposes.

The Bureau issues sucrose as a standard sample. Since it furnishes a source of pure carbon, and since its fuel value is accurately known, it is widely used as a calorimetric standard in the analysis of coal. It is also used as a saccharimeter standard as a source of pure invert sugar for use as a standard in sugar analysis and for other miscellaneous purposes. Dextrose, in highly purified form, is also used as a "reducing" sugar standard in sugar analysis.

Purified dextrose is also used in bacteriological work in differentiating bacteria. The Bureau supplies it to the Medical Supply Depot for use in this work in the United States Army. Equipment is to be installed at the Bureau capable of handling relatively large quantities of material, and it will then be possible to supply both sucrose and dextrose in considerable quantities.

**Sugar and Molasses at Southern Ports.**

The abnormally heavy importations of sugar and molasses through southern ports were continued during the year. The scarcity of ocean tonnage which became manifest over a year ago has continued, with the result that the importations appear at the most convenient port of entry regardless of whether the Customs Service of the Treasury Department has facilities for collecting the revenue at that port.

The laboratory which the Bureau has installed at the port of Savannah has been giving excellent results and has relieved the situation to a considerable extent. The Government's inability to equip new laboratories at Galveston and Key West has resulted in still further crowding the already overworked customs laboratory at New Orleans. It is hoped that it will be possible to relieve this condition at an early date.

**Standard Samples.**

During the past year 95 standard samples of sucrose and 16 samples of dextrose were distributed. These materials are used principally for industrial and scientific purposes.

**Polarimetric Testing.**

The Bureau continues to test large numbers of polariscope-tube cover glasses for optical homogeneity. All glasses tested were of American manufacture. Polariscope tubes, sugar weights, hydrometers, volumetric apparatus, etc., were purchased for the Treasury Department and tested.

**Polarimetric Tests of Raw Sugar.**

The Bureau has supervision of the sugar testing in the Customs Service, Treasury Department. In this connection, 1,509 exchange samples of raw sugar for control purposes were tested. Approximately 50 per cent were direct polariscope determinations of the quantity of sucrose present, and the remainder were tested for the percentage of moisture in addition to the sucrose content.

**Testing of Molasses.**

In view of controversies arising between buyer and seller of blackstrap molasses in regard to the quality of the same, the Bureau has consented to make referee analyses in a number of important cases. Sixty-one such analyses have been made during the past year. Whenever the work will permit, the Bureau will continue to act in this capacity.

**Filtration of Sugar Solutions.**

The separation of solids from sugar solutions has become a large factor in the manufacture of sugar, due to the constant increase in the cost of labor and of the filter cloths. The tendency now is toward mechanical means which separates the bulk of the solids, thus requiring less to be removed by cloth filters. To aid in the development of mechanical separation, the Bureau has, in its work on this problem, so related the various factors which influence mechanical separation that the behavior of the solid can be predicted over a wide range of varying conditions.

### Beet Molasses.

The middle western beet-sugar factories are troubled with a material appearing in the manufacturing processes which is optically active and forms solutions of extreme viscosity. The removal of sugar from solutions containing this unknown material is thereby rendered difficult. The Bureau has under way the identification and investigation of manufacturing processes to remove this material.

### Color of Sugars and Sirups.

There has been a great deal of confusion in the evaluation of the color of the various sugar products. The polarimetry and colorimetry sections of the Bureau have investigated and developed a method of exactly defining the value of the color presnt, and a report will be published on this important subject in the immediate future.

### Standardization of Methods of Sugar Manufacture.

The demands upon the Bureau for research work in connection with the standardization of the processes of manufacture of sugar have been so insistent that a section devoted to this work has been established. The work has received the hearty support of the various manufacturing interests. A number of research problems, in which the unusual facilities of the Bureau are particularly applicable, are now well under way.

### Molasses Density.

During the past few years the value of molasses, as well as the quantity consumed, has greatly increased. The determination of the density of the material has necessarily likewise risen in importance, the value being predicated to a considerable degree upon the density.

The Bureau has developed a picnometer in the use of which entrapped air can be removed and the density determined with greater precision than heretofore.

### Definitions and Specifications of Commercial Sugars.

At the present time about 40 varieties of sugar enter into direct consumption in the United States. A number of these are more or less similar, but, being made by different concerns, are sold under different trade names. They range in quality and color from the best grade of white granulated and cube sugars to the soft, dark-brown sugar.

It has long been an open question as to whether it would be practicable to prepare specifications and definitions of these sugars which would make possible their accurate identification. The trade names give little or no indication of the character of the sugar. During the year several hundred samples of these sugars have been received by the Bureau, and a systematic classification is being attempted by means of chemical analysis, moisture content, color, and numerous other chemical and physical properties.

The investigation is necessarily an extensive one, requiring much time for its completion. The results so far secured have been satisfactory. Suitable definitions and specifications now seem possible, and, if they can be accurately prepared, the result will be a matter of great importance to both the sugar manufacturer and the general public.

## COLORIMETRY.

(Measurement of the factors determining color; the optical transmissive and reflective properties of materials; ultra-violet and visual spectrophotometry; standardization of colorimetric nomenclature; development of methods and instruments for colorimetry; color grading of light sources and materials.)

Colorimetry is the measurement of the physical quantities which serve to specify color. Color is properly defined as a sensation. The ordinary stimulus of this sensation is light. Colorimetry, therefore, deals with measurements relating to light. The color of a substance under prescribed conditions is defined as the color produced by the light reflected or transmitted by it. The color of light is specified by its frequencies (or wave lengths), the relative intensities of the component frequencies, and their total intensity. The color white is commonly produced by light of all frequencies between about 400 and 750 vibrations per trillionth of one second (wave length, 750 to 400 millimicrons), in certain relative proportions, as they exist approximately in daylight. In general, light in which the component frequencies occur in different proportions than these causes a color other than white, and this color may be specified by these relative intensities and the total intensity. These ratios and intensities are measured by spectrophotometry and photometry, which are thus the basis of colorimetry. There are also various types of colorimeters by which light of specified frequencies is mixed in measured proportions to produce a color matching the color being tested. Color may also be empirically specified by reference to arbitrary colored standards.

The work comprised in this section deals generally with light sources, the transparency of materials, and the transmission, reflection, and diffusion of light and other radiant energy by materials. In some problems where color itself is not the prime consideration, still the measurements required and instruments and methods used are identical or similar. Such problems are, therefore, dealt with in this section. This work is closely related to and interlocks with other sections of the Bureau's work, viz, photography, photometry, and radiometry. Its methods find practical application in chemistry, ceramics, pyrometry, and the testing of textiles, paper, paints, dyes, oils, and other materials, and in specifications and regulations concerning railway and other signals and eye-protective glasses.

### Present Status of the Color-Standards Investigation.

For information relative to the nature and scope of the color-standards investigation, reference is made to the Annual Report of the Director, Bureau of Standards, 1918, p. 92. During the year progress has been made on each section of the work there outlined as the work which was being undertaken by the Bureau. Particular features of this work will be noted in the following paragraphs. The attention given to military investigations and tests during the two years past has greatly delayed progress on this investigation. On this account the investigation is about one year behind the stage it would have reached had the war not intervened. This delayed work has now been actively resumed, and every effort is being made to prosecute it with all possible speed.

The work now actively in progress or to which immediate attention will be given this year may be classified as follows: Continued improvement and extension of spectrophotometric methods; standardization of colorimetric nomenclature; investigation of "white light" and "average daylight"; application of rotary dispersion to colorimetrey; investigation of the spectral transmissivity of dyes (in cooperation with Bureau of Chemistry); investigation of spectral transmissivity of colored inorganic-salt solutions; investigation of colored railway-signal glasses; development of technologic methods for the commercial color grading of materials.

### Extension and Improvement of Spectrophotometric Methods.

As has been repeatedly emphasized in previous reports, the physical basis of colorimetry is spectrophotometry and efforts to improve, systematize, and simplify spectrophotometric methods have been continued. (See Ann. Reps., 1916, p. 87; 1917, p. 86; 1918, p. 93.) Definite accomplishments marking progress in this work during the year may be noted as follows:

*Visual Spectrophotometry.*—The improved illumination apparatus for the Koenig-Martens spectrophotometer, mentioned as under construction in last year's report, has been actually installed and used in extensive work. This apparatus provides for measurement of both spectral transmission and diffuse spectral reflection by very small and quickly made changes in arrangement. Both incandescent and mercury vapor lamps are installed in the apparatus, thus providing for illumination either by heterogeneous or homogeneous light. It gives a practically perfect photometric field, and is proving altogether very satisfactory in practice. Further thorough and detailed investigation of the precision and accuracy of measurement is in progress. A Bureau of Standards technologic paper describing this apparatus is in course of preparation.

A new spectrophotometer for liquids (oils, dye solutions, etc.) employing the principle of variation of thickness is partly designed. Measurements already made by this principle with an instrument made in the Bureau's shop are very satisfactory, and the method when perfected promises to afford a great improvement in the measurement of the transmissivity of liquids. It is planned to use such an instrument in color grading oils and in the investigation of dyes.

*Photo-electric Spectrophotometry.*—The new photo-electric apparatus mentioned in last year's report has been used with great satisfaction in many tests. A brief description of this apparatus has been published (Jour. Op. Soc. of Am., January–March, 1919); and a complete detailed description of it is now in press (Bureau of Standards scientific paper). Changes are being made by which a thermopile and galvanometer (thermoelectric method) may be used with the same apparatus. When it is thus amplified the apparatus will enable accurate measurements to be made over a wave-length range from about 380 millimicrons in the ultra-violet, all through the visible to about 1,000 millimicrons in the infra-red.

*Photographic Spectrophotometry.*—The Hilger sector apparatus has been used in many tests. Minor improvements have been made in the permanent installation.

*Correlation and Comparison of Methods.*—Each of the three methods mentioned above has its strong and weak points. Used together they serve to supplement each other in a very satisfactory way, for where one is weak another is strong. For very short wave length (less than 380 millimicrons, ultra-violet) only the photographic is used. For wave lengths between 500 and 380, both the photographic and photo-electric are applicable. The visual method is good between about 650 and 450, but more or less unsatisfactory beyond these limits. In the regions where two or more methods overlap they have been found to check very satisfactorily in careful work. The thermoelectric method when perfected will complete our requirements by providing means of measurement in the red and near infra-red (wave length 600 to 1,000 millimicrons).

*Temperature Control in Spectral Transmission Measurements.*—The light transmission of a substance is, in general, a function of its temperature. It is therefore necessary to make measurements for accurate work in many cases at a specified temperature, although the temperature regulation need not be very accurate. Thermostats have been designed to control the temperature of the sample in connection with the Koenig-Martens, the Hilger sector, and the Gibson photo-electric apparatus. These thermostats are now being permanently installed in connection with this apparatus. For the present we are only interested in ordinary temperatures, and these thermostats are therefore designed to operate only at temperatures from about 10° C. to 50° C. and will usually be used between 15° and 35°.

*Summary.*—The colorimetric section now has working equipment permanently installed to make spectral transmission and diffuse reflection measurements on short notice by different methods in a routine way, on a range of wave length from about 220 millimicrons to about 700 millimicrons, and apparatus for making transmission measurements at specified temperature is now being installed. Further study of accuracy and further efforts for improvement are being made, and the thermoelectric method will extend the range to about 1,000 millimicrons.

### Development of Technologic Methods for Commercial Color Grading of Materials.

From a utilitarian point of view, the end and purpose of the color-standards investigation is the development of methods and apparatus to provide for the routine technical color grading of materials in which color is a point of interest. This is the reason the industries urge the Bureau to do the work, and this is, in fact, the reason money is appropriated for it. Those in active charge of the work know that this end can only be attained by founding the method on accurate, thorough knowledge of the very recondite and, to the layman, unfamiliar facts and phenomena involved. They are also, however, keenly aware of the need of applying this knowledge in a practical way to the practical problems presented. Time, thought, and effort are therefore divided between fundamental research and its application. Below are noted some of the current problems on which progress has been made and, in some cases, definitive reports issued during the year.

*Color Grading of Cottonseed Oil.*—An investigation of the color of cottonseed oil has been in progress at the Bureau for a number of years. An important feature of this work has been the determination of the spectral transmissivities of a large number of representative samples. The Bureau has long been of the opinion that the simplest, the most definite, and, in the end, the most useful and significant method of color grading this oil would be in terms of its transmissivity for certain selected wave lengths. However, a requirement to be met was means for the translation of values on any new scale into approximate values on the Lovibond color scale, which has been in use in the cottonseed oil industry for perhaps 20 or 30 years. Investigation during the past year has led to the discovery of a simple relation which makes possible the preparation of such a conversion table of transmissivity ratios and Lovibond values for oils near "prime" in color. Recommendations on the color grading of cottonseed oil which were final and definitive, in so far as fundamental principles were concerned, were submitted to the Convention of Cotton Products Analysts, by the Bureau's representative. New Orleans, May 17, 1919. (Cotton Oil Press, July, 1919, pp. 86–88.) The essential features of these recommendations are as follows

1. Color grading in terms of colored glasses or other material standards should be discontinued except in certain particular cases where it may be desirable on account of convenience in quick reference or where apparatus for grading by the method proposed below is not available. The reasons for this recommendation are:

(*a*) Such standards are difficult to obtain and difficult to duplicate.

(*b*) The calibration and certification of a large number of them involves an immense amount of labor.

(*c*) They are of questionable permanency.

(*d*) The number of them necessary for a complete scale makes great trouble in practice.

2. The oil should be graded in terms of its transmissivity for monochromatic light of certain specified wave lengths.

3. Oil nearly "prime" in color should be graded in terms of its transmissivity for 1 decimeter for light of two-wave lengths, viz, 546 millimicrons and 578 millimicrons.

Making use of these measured transmissivities, it will be possible to express completely and uniquely both the quality (hue and saturation) and the brilliance of the color of the oil.

The Bureau will undertake to provide two conversion tables, viz:

(*a*) A table giving values on the Bureau of Standards' average Lovibond scale in terms of the ratios of the transmissivities for wave lengths 546 and 578 millimicrons to an accuracy limited only by the essential uncertainty of the Lovibond scale.

(*b*) A table giving the total transmissivity for average sunlight (brilliance of oil) in terms of the transmissivity for wave length 578 millimicrons.

The system of grading in terms of transmissivities possesses the following advantages:

1. It expresses an essential property of the oil itself. It is quite possible that the chemist in the future will find such data of much interest aside from its use in specifying color.

2. It is independent of any question of the observer's color vision. The measurements can be made just as well by a color-blind observer as by one having normal vision. This is by no means an unimportant consideration when it is remembered that railroad statistics show that 1 man in 20 is color blind.

3. It is physically simple and capable of precise specification in easily reproducible units and conditions, thus eliminating arbitrary, ill-defined, nonreproducible standards.

New apparatus is now being designed to provide for putting these recommendations into practical effect, and further cooperative work on details will be carried out in cooperation with the Society of Cotton Products Analysts.

*Color Grading of "Pyralin Ivory" for Du Pont de Nemours & Co.*—At the request of Du Pont de Nemours & Co., a minor investigation of the color of their product "pyralin ivory" has been made. Diffuse spectral reflection curves for a number of samples were made and a report forwarded to the company June 27, 1919.

*Color Grading of Sugar Solutions.*—Considerable work has been done on investigation of the spectral transmissivity of sugar solutions for samples from various sources and different concentrations. This work is in progress, and no reports have as yet been issued. Attention is being given to the formulation of suitable methods for routine work, and it appears at present that the solution of this problem will be comparatively simple.

*Color Grading of Various Materials.*—The materials which it is desired to grade by color in commerce are almost innumerable, including paints, dyes, inks, textiles, paper, flour, soap, tobacco, butter, and many other things. The Bureau's correspondence shows inquiries for information and advice on these problems from the most varied sources. In practically dealing with these problems general principles nearly always have to be specialized, and each problem requires individual treatment. Up to the present the Bureau has been able to give very few of these problems adequate attention.

A method for color grading of butter and oleomargarine was published several years ago (B. S. Tech. Paper No. 92), and since then this matter has demanded no further attention except in making a few tests in terms of the specification therein given.

Paper grading has been given a great deal of attention in regard to its transmission, diffuse reflection, and glaze. Previous publications (B. S. Circular No. 63 and Trans. Am. Cer. Soc., vol. 17, Detroit convention, 1915) have dealt with the paper problem in a partial way. Further work has been done and progress made, but this work has not yet reached the stage for a definite report.

### Standardization of Colorimetric Nomenclature.

One of the primary and urgent needs of colorimetry is an established and recognized nomenclature, as well as systems of units, standards, and symbols. During the year progress has been made in the formulation and standardization of these matters in the work of the colorimetric section, but it is necessary that general agreement be reached with all concerned. Action has been taken to bring this about, the Optical Society of America having formed, in January, 1919, a committee for this purpose with the chief of the Bureau's colorimetric section as chairman. It is expected that this committee will make a report in December, 1919.

### Data on the Spectral Transmission of Various Glasses in the Visible and Ultra-Violet.

The spectral transmissions of various colored glasses are a matter of great interest in colorimetric and related work, as they may serve as secondary standards and as "filters" for selecting light of particular colors. There has been need for a compilation of data on available glasses.

During the last three years the spectral transmissions of a great number and variety of glasses have been measured throughout the ultra-violet and visible. These data have now been collected and a paper on this subject is in course of publication (Bureau of Standards technical paper). The transmissions for the visible and ultra-violet of 87 samples of glass, representing over 50 different kinds, mostly colored, which are useful for various purposes, are given in this paper. The glasses listed are representative of what may be obtained to-day on the American market, and include also some of foreign make which could be obtained before the war. It is thus possible to make comparison of the relative merits of foreign and American glass and see in what respects the latter may duplicate or improve upon the former.

All of the glasses listed in this paper, so far as it was possible to get values, were measured photographically and visually and in most cases photoelectrically. The photographic (Hilger sector photometer with quartz spectrograph) method may be used from 230 to 500 millimicrons, the photoelectric null method from 380 to 600, and the visual (Koenig-Martens spectrophotometer) from 436 to 720. The data are presented in the form of transmission curves extending from 720 millimicrons throughout the visible and ultra-violet as far as the specimens have any appreciable transmission. The methods overlap to such an extent that when all are used extremely reliable curves may be obtained. With possibly a few exceptions, therefore, the curves as given are considered accurate within 0.02 on the transmission scale of 0.00 to 1.00, and in many cases, especially at low transmissions and in the better specimens, the uncertainty is definitely less than this.

For each specimen are given the transmission curve, the thickness, the trade name or designation, and the maker or dealer. In each figure also is given the relative visibility curve for the average human eye. An inspection of the curves must be made by those interested, inasmuch as this kind of data can not be summarized.

Various practical uses to which these glasses are put are indicated, such as ultra-violet signaling, railway signaling, improvement of visibility both for visual and photographic work, protection of the eyes, and selective ray filters. Of special value in scientific work is their use as filters to obtain monochromatic light from mercury, helium, or hydrogen lamps. Transmission curves of such filters are given.

**Investigation of Railway-Signal Glasses.**

As is well known, colored lights are almost universally used on railways to indicate "danger," "stop," "safety," "clear," "caution," etc. It is by the guidance of such lights that the engineer operates his train. These colored lights are largely obtained by placing colored glasses in front of oil or electric lamps. The standards for these glasses should be specified in terms of spectral transmission, and indeed the standards of the Railway Signal Association are so specified. It is a matter of prime importance to public safety that the proper standards be maintained and adhered to rather closely in practice, which means a certain amount of spectrophotometric testing. Appreciating this, the Pennsylvania Railroad has frequently required such tests of this Bureau, and has lately requested that the Bureau undertake a more extensive and thorough investigation of makers' working standards. It is to be understood that, while specifications are written in terms of spectral transmission, not every glass to be put to use can or need be tested in these terms. The manufacturers keep certain particular glasses as working standards. Question has been raised as to the authenticity and uniformity of these working standards, and as the railways themselves are without spectrophotometric equipment, and therefore unable to test the glasses delivered, the question has accordingly been referred to the Bureau. Copies of the makers' working standards have been obtained and are now in course of investigation. It is expected that a report will be published within a few months (Bureau of Standards technical paper).

**Investigation of Eye-Protective Glasses.**

Many glasses have been recommended and extensively advertised to absorb injurious radiant energy, and so protect the eyes when worn as spectacles or goggles. However, physiologists and oculists desiring to conduct experiments to determine the value of such glasses have little to guide them in their selections except the claims of makers and sales agents. In order to experiment or prescribe intelligently, it is obviously necessary that authentic and authoritative data should be available on the spectral transmission of the various glasses which are being commercially promoted as valuable in protecting the eye from harmful radiant energy. Feeling this need of data, Dr. W. C. Posey, chairman of the committee on hygiene of the eye, American Medical Association, formally requested this Bureau to make an investigation of the spectral transmission of these glasses.

The report on this investigation has now been published. (Bureau of Standards Technical Paper No. 119.) In this paper are given the results on 82 samples of eye-protective glasses which are at present on the American market, the list including various shades of glasses sold under the following trade names: Akopos, Amber, Amethyst, Arkweld, Blue, Chlorophile, Chromatic Test, Cobalt Blue, Crookes, Electric Smoke, Euphos, Fieuzal, Hallauer, Luxfel, Noviol, Noviweld, Pfund, Rifleite, Saniweld, Smoke, and others, including heat-absorbing, welding, and colorless crown glasses. Some of these specimens are of unknown origin, glasses which have been marketed for years under more or less well-recognized trade names. The data given show what may be obtained under one of these names;

but, as there are usually so many different shades of the same kind of glass marketed under the single trade name, it can not be expected that duplicates can be obtained merely by ordering by name. However, most of the specimens, especially those of American manufacture, are designated by shade—that is, "A," "B," etc.—as well as by trade name or by number and in this case it is expected that approximately duplicate samples can be obtained. Yet in no case, probably, is the designation a sufficient specification; but the oculist or buyer, guided by the data given in this paper, may now prescribe or order glasses of specified spectral transmission, acceptance being subject to test.

By means of tables and curves the results of the investigation have been presented in such a way that the information desired may be quickly obtainable. For each specimen is given: The trade name (including the shade designation) under which it is marketed; the company from which it may be obtained; the approximate color; the thickness, the samples being from 1.42 millimeters to 3.20 millimeters thick, that ordinarily used in spectacle lenses. The per cent transmission curve from 230 to 710 millimicrons (in each figure there is also given for comparison the transmission curve of a sample of colorless crown glass and the visibility curve for the average human eye); the total transmission for light of equal energy at all wave lengths, computed from the visibility curve and the transmission curve.

### Precision Determination of Spectral Transmission of Visibility Solution.

A ray filter or screen which transmits energy of different wave lengths in proportion to its visibility is known as a "visibility filter." A solution of cupric chloride, cobalt-ammonium sulphate, potassium chromate, and nitric acid in water in a glass cell produces approximately this result. Such filters are necessary in physical photometry. The spectral transmission of such a filter must be known.

At the request of Dr. H. E. Ives, the spectral transmission of a solution made according to a formula submitted by him has been determined. The solution was prepared by the chemical division at the Bureau according to the formula submitted: Cupric chloride ($Cu\,Cl_2 . 2H_2O$), 61.25g.; cobalt-ammonium sulphate ($Co\,SO_4 . (NH_4)_2\,SO_4 . 6H_2O$), 14.5g.; potassium chromate ($K_2\,Cr\,O_4$), 1.9g.; nitric acid (Sp. Gr. at 15°, 1.05), 18.0 centimeter; water to total volume of 1 liter. The ratio of the transmission of a 1.03-centimeter glass cell containing this solution to the transmission of the same cell filled with distilled water was determined with great care by both the visual and photoelectric methods, the total wave-length interval covered being about 440 to 670 millimicrons. A complete detailed report was issued to Dr. Ives, March 22, 1919, but has not as yet been published otherwise. It is expected that publication may be made later in suitable connection. In the meantime the data may be obtained on application to the Bureau by any one interested.

### Calibration of "Munsell Color Standards."

The Munsell Color System (Wadsworth, Howland & Co., Boston, Mass., and Munsell Color Co., New York) has attained considerable importance and recognition in art, and particularly in color printing.

This system has many good features, but, unfortunately, it was developed and put into practice without adequate fundamental standardization. Lately the Munsell Color Co. has submitted its standards to the Bureau for calibration. The spectral diffuse-reflection curves of 24 samples have been determined, and a complete report made to the company. This report has not been published, but the data may be obtained from the Bureau by anyone interested in it.

As one result of the calibration, it appears that the Munsell " value " numbers are not proportional to diffuse reflection, as seems to be understood in Munsell's Color Notation, but actually the squares of these numbers are strictly proportional to diffuse reflection. This suggests some confusion in the fundamental concepts and basis of the system. The diffuse reflections of the Munsell value scale do not form a geometrical series as in a " natural " scale of value.

### New Radiation Formula.

The energy given out by a complete radiator is a complex function of the wave length and the temperature of the radiator. Many formulas have previously been proposed to express this complicated relation. The earlier ones, due to Wien and Rayleigh, were long ago found to be only approximate, not fully representing the actual experimental facts. A formula representing the experimental data much more closely was later devised by Planck. In working over the old experimental data in connection with his colorimetric work a member of the colorimetry section has discovered an empiric relation of a form quite different from that of Planck and representing the data apparently even better than Planck's formula. The equation or formula representing this relation has been published (Jour. Op. Soc. of Am., January–March, 1919, and Phy. Rev. (2), 13, 314, 1919) and has proved to be of some interest.

### Colorimetric and Related Tests.

Twenty-six test reports giving data on about 90 specimens or pieces have been issued. The data given were for the most part spectral transmission in the visible and ultra-violet, but included also reflection measurements, as well as relative spectral-energy distribution in light sources. Eleven of these reports were on military tests for the Army, Navy, and National Research Council.

### Information Furnished on Color, Colorimetry, and Related Subjects.

Information in response to requests has been furnished on color, colorimetry, colorimetric apparatus, and related subjects, both by letter and personal conference with visitors. About 90 such letters of information were sent and about 60 such visitors given oral information.

### Military Investigations.

As mentioned above, a great deal of time has been taken from the work on colorimetry proper to undertake military investigations. This was mentioned in last year's report; but at that time it was not permissible to mention these investigations specifically. The occasion for secrecy now having passed, some account of this work may properly be given. It was for the most part done in the preceding fiscal year, although some of it has extended into the year of this report.

### Ultra-Violet Signaling.

Several months before the entry of the United States into the war the Bureau of Standards was requested to advise the Navy as to the selection and specification of a lamp to be used as a stern light so designed that it would be visible to other ships of the same squadron at 1,000 yards astern, while not visible at greater distances and not easily picked up by enemy ships.

This request suggested the possibility of screening the source with a filter transparent to ultra-violet, while opaque to the visible and observing it with a fluorescent detector. Experiments made at the Bureau, February to May, 1917, showed in general the feasibility of this idea, and a letter to this effect was delivered to Admiral R. S. Griffin, June 1, 1917. A detailed technical report was made to Admiral Griffin, March 6, 1918. A paper on this subject was presented to the American Physical Society, Washington, April 26, 1919, and it is expected that an abstract of this paper will be published in the Physical Review.

Methods of ultra-violet signaling were also developed independently by others outside of the Bureau about the same time and the Bureau later assisted these experimenters by performance of tests and loans of apparatus.

### Visual Detection of Submarines.

Immediately after the entry of the United States into the war the detection of the submarine was perhaps the most pressing of all war problems. In the course of time various means of detection were developed, some of them highly technical and complicated. At the outset it appeared that the simplest means of detection—viz, sighting the submarine or its periscope—should not be neglected, but developed to its highest possible efficiency. The National Research Council appointed a committee, on which the Bureau of Standards was represented, to consider and make recommendations on this subject, in particular in regard to aids to vision, methods of observation, and development of the lookout service.

The report of this committee (dated July 13, 1917) was prepared at the Bureau and transmitted to the National Research Council July 23, 1917. A supplemental report was made October 6, 1917.

### Chromatically Concealed Insignia and Detection of Chromatic Camouflage.

Owing to the fact that different spectral distributions of light may give the same color, it is possible to have samples accurately color matched as examined by the unaided eye in daylight, and still show glaring chromatic contrast when examined through suitable light filters (colored glasses, etc.). This circumstance was a source of danger to the camouflage artist. For example, a fabric might be dyed green to closely match green foliage, and through a properly chosen filter it might appear bright red on a dark green or black background of normally green foliage. Indeed, it might be about as conspicuous as a fire at night. On the other hand, it might, through another filter, appear dark on a bright-red background of normally green foliage.

At the request of the War Department, the Bureau made several tests of materials in this respect and was able to recommend dyes and select fabrics to overcome this difficulty.

The Bureau did not itself undertake a comprehensive and unified investigation of the subject of "camouflage." However, a great deal of work bearing on it was done at the request and instigation of others working on these subjects. A great deal of oral information on ray filters, spectral transmission, and reflection and chromatic camouflage, often illustrated by experimental demonstration, was given to officers of the Army and Navy and representatives of the National Research Council. Ray filters were loaned from stock, and others were made to order of prescribed properties and supplied to the applicants for them.

The Bureau was also asked to investigate the practical possibilities of chromatically concealed insignia; that is, insignia woven, painted, or made in such a way that they would be invisible to the unaided eye in daylight and be rendered visible by examination through properly selected filters. Many combinations of dyed fabrics were prepared which were nearly or quite indistinguishable to the unaided eye, but showed remarkable color differences when examined through suitable filters. These were exhibited and explained to numerous representatives of the War and Navy Departments. An exhibit of some of these was made in connection with the American Physical Society exhibit at the Bureau, April 25–26, 1919.

**Publications.**

Numerous reports were issued. Some of them were of no interest except in the particular circumstances of the test at the time. Those which may be of some permanent interest are listed below:

1. Letter to General Engineer Depot on Visibility of Green Tape; May 17, 1918.
2. Visual and Photographic Tests of the Visibility of Green Tape, submitted by General Engineer Depot, Bureau of Standards test No. 23667; June, 1918.
3. Visual and Photographic Tests on the Visibility of Green Tape, submitted by Office of Quartermaster General, Bureau of Standards test No. 23978; August 12, 1918.
4. A Green Cotton Dye to Simulate Green Foliage; November 12, 1918.
5. Spectral Transmission of Eight Aviator Goggles from England, submitted by National Research Council (subsequently identified as "Brock goggles"); June 13, 1918.
6. Spectral Transmission of Screen Prepared by C. E. K. Mees to Duplicate Brock No. 61, submitted by science and research division, Bureau of Standards test No. 24034; August 23, 1918.
7. Optical Duplication of Light Filter Known as "Brock No. 61"; September 9, 1918.
8. Duplication of Light Filter Known as "Brock No. 61" (supplement to Report of September 9); September 30, 1918.
9. Spectral Transmission of Two Pairs of Anticamouflage Goggles, submitted by Navy Department, Bureau of Standards test No. 23662; June 22, 1918.
10. Dichromatic Red-blue Screens Prepared by Bureau of Standards for Navy Department; supplement to Bureau of Standards test No. 23662; July 9, 1918.
11. Letter to Bureau of Construction and Repair, Navy, Describing Preparation of Dichromatic Filter Made to Order to Duplicate Prescribed Spectral Transmission; October 9, 1918.

12. Diffuse Reflecting Powers of 13 Samples of Painted Canvas. submitted by development branch, photographic section, Bureau of Aircraft Production, Bureau of Standards test 23880; August 30, 1918.

### Optical and Photographic Methods for the Detection of Invisible Writing.

Early in the war it was suspected with more or less plausibility that German agents were using so-called "invisible inks" in their communications. The secret service agents of the Government had intercepted and held on suspicion vast quantities of correspondence, and the Bureau of Standards was asked for advice as to methods of examining this for the suspected invisible inscriptions, which, if existent, could doubtless be developed and read by suitable means. Development and supervision of chemical tests was assumed by other agencies, and this Bureau undertook only the matter of optical and photographic tests. Special apparatus was designed and constructed at the Bureau and used by the offices of the Naval and Military Intelligence. The purpose of this apparatus was to provide convenient and rapid means for the routine examination of a great number of pieces. The methods for regular routine examination were the following: (*a*) Examination in intense light at grazing incidence; (*b*) examination by regular reflection; (*c*) examination by transmitted light; (*d*) examination in extreme violet and ultra-violet light; (*e*) examination by ultra-violet photography.

The first three tests mentioned above involve essentially nothing more than specific control of the direction of illumination and the line of sight in the examination of the paper. It is a matter of common observation that faint marks, erasures, indentations, etc., on a sheet of paper can be seen much better at certain angles than at others. The apparatus for tests (*a*) and (*b*) merely provides convenient and comfortable means for the critical examination under two specific conditions, both of which greatly accentuate the appearance of irregularities in the paper surface. For test (*c*) the paper was laid on a ground glass illuminated from below. No special apparatus needed to be constructed, as an Edison mimeoscope served this purpose very well.

Methods (*d*) and (*e*) are somewhat further removed from ordinary experience, and so require more explanation.

Method (*d*) depends upon fluorescence; that is, the property which many substances possess of emitting light when excited by ultra-violet rays which themselves do not cause vision.

Inscriptions made with such substances, dissolved and used as inks, may be quite invisible in ordinary light under any kind of illumination, but show up in bright characters on the darker background of the paper when excited by ultra-violet rays. Paper itself, in common with many materials, is fluorescent in varying degree. If the ink is composed of a substance less fluorescent than the paper, or if the solvent dissolves the surface glaze, the writing will show dark on a light background. Inscriptions written with pure water may be detected in this manner on some kinds of paper.

The test is performed by allowing ultra-violet rays to fall on the paper in a dark room. The ultra-violet is obtained from a Cooper-Hewitt glass mercury lamp screened by a glass which absorbs nearly all of the light from this lamp while it transmits very freely the ultra-violet and a small amount of violet light.

Method (*e*) depends upon the fact that some substances may be so nearly the color of white paper as to produce little or no contrast when inscribed on it, while they may differ from it sufficiently in their absorption for ultra-violet as to give noticeable contrast in an ultra-violet photograph. For this purpose ultra-violet rays of wave length considerably shorter than used in the fluorescence test were employed. The quartz-mercury arc and the iron arc are suitable sources for such rays. The blue and violet light and the longer wave length ultra-violet are absorbed by an aqueous solution of nickel sulphate and gaseous chlorine in quartz cells. Since these rays are absorbed by glass, the lenses used must be made of quartz, fluorite, or other material which will transmit them.

Five illustrated technical reports on this subject were issued to the Office of Naval Intelligence during the war. Information on this subject was also given to the division of Military Intelligence. An exhibit of the apparatus used was included in the American Physical Society exhibit at the Bureau; April 25–26, 1919.

The methods developed are also of use generally in the critical examination of paper and documents. Last April the Bureau was able to decipher the name and address on a military-registration card sufficiently well to establish certain identification of the bearer after the card had been immersed in sea water with the dead body of the drowned registrant so long that it was quite illegible to ordinary observation and the body itself was completely unrecognizable.

### A Method for Color Grading of Red Signal Flares.

At the request of the American University Experiment Station, a method for color grading red signal flares was developed and a report issued in July, 1918. This method had also been described in a communication to the American Physical Society and is now in course of publication (Phy. Rev.).

### Searchlight Investigation.

The high-power search lamps have acquired tremendous importance in the last few years. Few data, however, are on record regarding some of the fundamental characteristics of these search lamps or bearing upon some of the fundamental problems under searchlight illumination. An investigation in cooperation with the Corps of Engineers of the Army has been carried on, using the combined facilities of the colorimetry section of the optics division and the photometry section of the electrical division at the Bureau. This work is briefly described below.

From data collected by the Bureau, two distinct types of distribution appear: That in the medium intensity arcs resembles a " rose " distribution; that in the high intensity a " cardioid " distribution.

The development of high-intensity arcs by the use of specially prepared carbons has resulted in the production of a light which is very blue relative to artificial incandescent sources. In a general investigation of searchlights, including the effectiveness and suitability of their illumination for various purposes, it appeared desirable to have at least approximate quantitative data on the color of this light.

An investigation was made by spectrophotometric and special colorimetric methods and a report was issued to the Corps of Engineers and others January 23, 1919. Another report was made to the American Physical Society April 25, 1919, and will be published in the Physical Review.

The result of these investigations may be roughly summarized by saying that the color of the light from these arcs is approximately equivalent to the light of the noon sun at Washington, although relatively more intense in the blue-violet.

The diffusion or scattering of light along the path of a searchlight beam is very important from several standpoints. The diffusion of the light out of the beam decreases the intensity of light falling upon the target. This diffused light limits the visibility of the target for an observer near the search lamp who must look through and along the beam. On the other hand, this diffusion of the light along the beam makes possible the use of the searchlights as landmarks for military and other purposes; and also facilitates the training of the beam in a given direction, particularly when combined action of two or more search lamps is desired.

Measurements have been made from various directions of the brightness of the path of the beam due to the diffusion of the light by the atmosphere. The per cent of polarized light in the diffused light has also been determined.

In order to make any conclusions as to the size and distance of a given target that may be seen in a searchlight beam, there is demanded some knowledge as to what is the minimum difference of brightness that the eye can detect. Laboratory experiments were made to collect data upon the contrast sensibility of the eye under conditions closely simulating those under actual searchlight illumination. Very definite results have been obtained.

In connection with the testing and use of search lamps the question of how much light is lost as the beam penetrates the atmosphere must be considered. It is important to know what the transmission of the atmosphere is when tests are made at great distance from the search lamp.

Very meager definite data exist upon the transmission of the atmosphere under all weather conditions—clear, hazy, foggy, rainy, etc.

It is important also to have a knowledge of the relative transmission for different-colored lights.

A method has been devised to procure relative data on the transmission of the atmosphere throughout the spectrum, and some observations have been made for a clear atmosphere, for one of rather high humidity, and for rains. Other kinds of weather could not be taken advantage of thus far. It is planned, however, to continue these observations for foggy weather.

These data are not only valuable for the searchlight engineer, but are important also in aerial and other photography and to the illuminating engineer interested in automobile head lamps, etc.

A chart has been made showing where all losses of light in the search lamp take place, and their magnitude from the moment the current flows through the arc to the time that the beam impinges upon the target.

A physical photometer is under construction for use in connection with the photometry of search-lamp arcs. On account of the high intensity of the light from arcs they are admirably adapted for the application of the physical photometer.

## OPTICAL INSTRUMENTS.

(Design of optical instruments; testing and research on optical systems, optical instruments, and appliances such as telescopes, binoculars, cameras, gun sights, and the like, and optical parts such as lenses, prisms, mirrors, parallel plates, etc.)

### Effect of Striæ on Optical Glass.

An extended investigation has been conducted on the subject of striæ in optical glass and their effect on the performance of the completed optical instrument. Numerous photographs have been taken showing the degree of striation in the glass and the corresponding effect upon the definition of instruments in which the striated glass has been used. The results of the investigation made on the subject of striæ are being prepared for publication. Though difficult to give any but a photographic measure of the amount of the striæ, it may be said in general that striæ, if faint or few in number, are not very injurious in the objectives of binoculars, but considerably more so in the prisms and oculars.

### Refractometer Design.

The two standard types of refractometer, an instrument for measuring refractive indices, are known as the Abbé and Pulfrich. Until recently all such instruments were made in Germany. Their Abbé type was accurate to five units in the fourth decimal place, while the Pulfrich was accurate to one or two units in the fourth. Since the beginning of the war other countries have entered the field and some little effort has also been made to develop American instruments of these two types, which would be more accurate than those of foreign manufacture.

A design for an improved type of Pulfrich refractometer, in which the scale is horizontal instead of vertical, as in the old type, has been worked out in the Bureau. The error of this instrument should be less than that of the German instrument, not greater than two units in the fifth decimal place, as compared with, say, one or two in the fourth for the German instrument.

An Abbé type of refractometer has been designed recently by an American manufacturer with the aid and advice of the Bureau. The Bureau made a careful examination of the preliminary model and recommended several changes. The final instrument, when actually tested, was found to be accurate to five units in the fifth decimal place, making it the most accurate of this type which the Bureau has tested.

### Circular Letter on Methods of Silvering Glass.

In response to numerous requests for information on the subject of silvering glass, a circular letter of information was prepared in which all the standard methods were collected and put into convenient form.

### Camera for Photographing the Inside of a Machine-Gun Barrel.

The Machine-Gun and Small-Arms Section of the Engineering Division of the Army has been studying the deterioration of the inside of machine-gun barrels due to the action of the hot powder gases. Their practice has been to fire a few thousand rounds and then saw the barrel lengthwise. Being desirous of studying, however, the successive stages of deterioration, they requested the Bureau to devise means for examining the interior of the barrel without impairing the usefulness of the firearm. A special camera has, therefore, been designed to permit the taking of a panoramic photograph of the inside of the barrel. It is now being constructed in one of the Bureau's shops.

### Night-Firing Device.

A small projection device for throwing a spot of light on a plotting board for use in connection with night firing was designed for the Ordnance Department of the Army. Two of these devices were built for this Department in the shops of the Bureau.

### Condenser System.

At the request of the Medical Service of the Army, a suitable set of condenser lenses to be used with an acetylene flame for microscopic work in the field was completed and submitted to the Medical Supply Depot.

### Calculation and Removal of Certain Errors in Centered Systems of Lenses.

In designing and in testing a system of lenses—e. g., for a telescope or camera—the refined calculations by trigonometric functions are not necessary for the treatment of errors of the lower orders. Those errors can be computed to first and second approximations by algebraical formulas. For this purpose tables have been devised. One set of tables with graphs to expediate a preliminary survey, has been computed and put in use—the table for eliminating spherical aberration. By means of this it is estimated that results can be obtained in one-tenth the time formerly needed. A paper soon to be published describes this work in detail.

For eliminating astigmatism a table is partly finished which will simplify the work. It is so devised that the two errors—those of spherical aberrations and of obliquity—are computed together giving the position and curvature of both astigmatic image surfaces.

Chromatic aberration is, in practice, removed in advance of these other two errors by proper choice of focal lengths.

### Testing of Optical Systems.

The Bureau was called upon to make various tests on a wide variety of optical instruments. Periscopes, small range finders, gun sights for both Army and Navy, bombing sights, in addition to the more common types of instruments, were brought to the Bureau for both test and advice. In some cases the work done has been comprehensive; in others the assistance rendered consisted simply in a short conference in which certain details of the instrument were discussed and inspected.

(*a*) *Tank sight.*—The Bureau cooperated with the Inspection Division of the Ordnance Department of the Army in the development of a tank sight. Both the consulting and the laboratory facilities of the Bureau were used freely for putting the instrument on a production basis. The range scale for it was computed at the Bureau and a representative of the optical instrument section made a special trip to Boston in connection with the production of the instrument.

(*b*) *Gun sight.*—The Bureau cooperated to a considerable extent with the Inspection Division of the Ordnance Department in the development and testing of 37-millimeter gun sights.

(*c*) *Machine-gun panoramic sight.*—A conference on the specification for the panoramic sight for machine guns was held at the Bureau on July 15, and from then on up to the time of the signing of the armistice the Engineering Division was in frequent consultation with the Bureau with reference to the specifications and performance of this instrument.

(*d*) *Periscopic alidade.*—A French periscopic alidade was sent from the Expeditionary Forces to the General Engineer Depot with the request that the instrument be copied and supplied to the American forces. The instrument was turned over to the Bureau, where its component parts were carefully measured and drawings necessary for the construction of a similar instrument furnished the Engineer depot. From these the Central Scientific Co., an American firm, made a sample instrument, which was returned to the Bureau for inspection. This instrument, after a few minor changes, was approved.

### Binoculars.

A large portion of the activities of the optical-instrument section was centered upon the testing of binoculars. The Bureau was requested to perform check inspections on one out of every hundred binoculars produced for the United States Army. Special apparatus was designed and built for the rapid testing of these instruments. This testing apparatus was adopted by the Signal Corps, who borrowed a member of the Bureau staff to take charge of the Signal Corps inspectors and Bureau methods of testing at the various factories. A school for the instruction of inspectors of binoculars, lasting three weeks, was held at the Bureau during October. This was attended by 10 Signal Corps' inspectors, who were, after receiving their training, sent out to the various factories to perform acceptance tests on binoculars.

A manufacturing company undertook the manufacture of binoculars for the Signal Corps. They had considerable difficulty at first in getting the optical parts of the binoculars properly placed in the instrument and referred some of their troubles to the Bureau, which was able to be of assistance in getting this company on a production basis.

In consultation with the Bureau of Standards another company embarked on the manufacture of a new type of binocular in which the machine work is largely replaced by pressed metal parts. This company has produced a very promising binocular.

Tests extending over a period of three months were made on the lenses of six Army field glasses for the purpose of determining the rate of growth and development of blisters in the cementing compound of the lenses. In general, it was concluded that lenses with bubbles or blisters in the cement should not be used in an instrument because of the probability of the defects increasing in size, and, furthermore, that the final inspection of lenses should not take place sooner than two weeks after they have been cemented.

The United States Shipping Board, Emergency Fleet Corporation, gave orders for 1,000 binoculars to be used on board the merchant marine, and requested the Bureau to perform acceptance tests on each instrument. Something over 1,500 binoculars were tested in order to secure the 1,000 acceptable instruments. The two main causes of rejections were lack of parallelism of the two barrels and failure of the two barrels to be simultaneously in focus. At first the rejected instruments were returned to the factory for readjustment, but later on the need for these instruments became so great that the rejected instruments were adjusted in the Bureau laboratory and immediately forwarded to the Shipping Board.

### Determining Constants of Optical Glass.

All the melts of optical glass made at the Pittsburgh laboratory of the Bureau, about 300 in number, have been submitted in samples to the optical-instruments section for the determination of the refractive indices, dispersions, and transmission factors.

The refractive indices and dispersions were at first determined on a spectrometer. This method involved the expense and delay incident to the making of a small and accurately finished prism of each kind of glass. Subsequently a Pulfrich refractometer, which requires only a small slip of glass about 2 by 10 by 20 millimeters in size, polished on one face and one end, was substituted for the spectrometer and the measurements thereby greatly facilitated. A Martens polarization photometer served for measuring the transmission.

In addition to testing Bureau of Standards melts, measurements of the same sort for a number of other manufacturers of optical glass were made, as also the customary index determinations of other substances.

### Tests of Instruments.

Following is a list of tests made by the Optical Instruments Section:

| | | |
|---|---|---|
| *Binoculars.* | | |
| For Signal Corps | 1,165 | |
| For Naval Ordnance Bureau | 13 | |
| For Shipping Board (acceptance tests) | 851 | |
| For private individuals | 5 | |
| | | 2,034 |
| *Military telescopes.* | | |
| Navy sighting telescopes | 2 | |
| Gun-sight telescopes | 10 | |
| Telescopic sights | 2 | |
| Tank sights | 12 | |
| Machine-gun panoramic sights | 5 | |
| Bore sights | 4 | |
| Aiming circles | 1 | |
| Range finders | 4 | |
| Trench periscopes | 6 | |
| Periscopic alidades | 8 | |
| Azimuth telescopes | 2 | |
| Telescopic clinometers | 2 | |
| Sextants | 1 | |
| | | 54 |
| *Lens systems.* | | |
| Photographic lenses: | | |
| Complete tests | 11 | |
| Focal lengths | 27 | |
| Radii of curvature | 18 | |
| Other lenses: | | |
| Focal lengths | 76 | |
| Radii and constants | 22 | |
| Centering | 72 | |
| | | 226 |

*Optical glass.*

| | | |
|---|---|---|
| Indices of refraction and dispersion constants | 218 | |
| Transmission factors | 191 | |
| Indices and dispersions of substances other than glass | 27 | |
| | | 436 |

*Miscellaneous.*

| | | |
|---|---|---|
| Lens test plates, radii of curvature | 28 | |
| Refractometers | 4 | |
| Parabolic mirrors | 4 | |
| Goggles | 75 | |
| | | 111 |
| Total | | 2,861 |

## RADIOMETRY.

(Development of standard instruments and methods of measuring thermal radiation, commonly designated ultra-violet, visible, and infra-red rays; determination of the reflective, absorptive, and emissive properties of materials for thermal radiation; development of standards of thermal radiations; determination of radiation constants; and the measurement of thermal radiation in absolute value.)

### Radiometry.

Investigations in the general subject of radiometry were greatly interrupted by military work. Research work on the improvement of radiometric devices was carried on with the view of making a practical application in signaling by means of thermal radiations. As a result the investigation of the radiation constants, upon which progress was mentioned in previous reports, has been in abeyance.

A study of the data published by Kahanowicz indicates that if a correction is made for atmospheric absorption the value of the coefficient of total radiation (Stefan-Boltzmann constant) obtained by that experimenter is in close agreement with the value $\delta=5.72\times10^{-12}$ watt, $cm^{-2}$ $deg^{-4}$, recently obtained in this Bureau.

A further examination was made of the accuracy of the factors used in converting the prismatic spectral-energy curve into the normal-energy distribution. Graphical methods were employed; also computational methods using the first differential of the dispersion formula which best represents the observed refractive indices of fluorite. Owing to incompleteness of the formula, the graphical method is just as accurate as is the method of direct computation. The conclusion arrived at is that the spectral-radiation constant, $C=14353$ micron deg., determined some years ago, remains unchanged.

Among the minor investigations was a determination of the utility of ribbed and hammered glass, as compared with plane glass, in greenhouses. The conclusion arrived at is that, aside from preventing direct sunlight from striking the plants, there appears to be no particular advantage in using a special glass in greenhouses.

### Some Optical and Photoelectric Properties of Molybdenite.

A thorough investigation was made of some of the optical and photoelectric properties of the sulphide of molybdenum, molybdenite. The transmissive, reflective, and polarizing properties were determined.

Extensive data were obtained on the spectral photoelectric sensitivity of molybdenite as affected by temperature, intensity of the energy stimulus, humidity, etc. This substance is unique in having three well-defined bands of photoelectrical sensitivity. Moreover, the positions of these maxima, when plotted in terms of frequency instead of wave length, are separated by equal intervals. This phenomenon does not appear to have been observed heretofore and will form the basis of a new line of investigation in photoelectric phenomena. An important application of these data was made in signaling by means of infra-red rays, as described in a subsequent paragraph.

### Spectral Photoelectric Sensitivity of Silver Sulphide and Other Substances.

In connection with the development of radiometric instruments for signaling by means of invisible radiations, an investigation was made of the spectral photoelectric properties of various substances.

New and important data were obtained on the spectral photoelectric sensitivity of the sulphides of bismuth and silver. The minerals pyrite, cylindrite, jamesonite, and galena did not show photoelectrical sensitivity for the highest spectral-radiation intensities available.

The effect of temperature, of intensity of the exciting light, and of mechanical working upon the photoelectrical sensitivity of silver sulphide was investigated.

At room temperature the photoelectrical sensitivity of crystalline silver sulphide, acanthite, is affected by a polarization phenomenon which disappears at low temperatures. The investigation of these materials has provided new data, the importance and the application of which will no doubt become more apparent as our knowledge of these phenomena is increased. As matters now stand, there is no satisfactory explanation of the cause of photoelectrical sensitivity in substances, and further investigation is highly desirable.

### Thermal Radiophonic Signaling Devices.

In the transmission of intelligence by means of invisible thermal radiations radiometry attained one of its greatest triumphs and one of its most far-reaching applications.

The unusually high photoelectrical sensitivity, as well as the quickness of response, of molybdenite, for infra-red rays renders this substance far superior to selenium as a radiophonic signaling device.

Successful field tests were made, using simply a receiver of molybdenite, which was connected through a dry battery to the input side of an audion amplifier. The source of radiation was a small tungsten lamp in an automobile headlight reflector. A rotating sector interrupted the light incident upon the molybdenite and produced a pulsating current, which was amplified, thus producing a loud musical sound in the telephone receiver. Tests were made also using the light of the moon as a source of infra-red radiation. Loud signals could be produced with infra-red lunar radiations having an energy value of only $3 \times 10^{-7}$ gr. cal. per second.

### Ultra-Violet Signaling.

The rotating sectored-wheel device for producing a pulsating current in a photoelectric substance, and hence an audible sound in the telephone receiver of a radiophonic signaling device, is inefficient. Apparatus was devised which utilized all the incident radiation, as well as a long exposure of the receiver, which is not possible with a sectored wheel. The signal was recognized by a change in pitch of the sound in the telephone receiver, which was used with an audion bulb. It was found that the molybdenite receiver is not as efficient as is a photoelectric cell of the gas-ionic type (e. g., the potassium-hydride photoelectric cell), which happens to be sensitive only to the ultra-violet and visible rays, but which appears to be especially adapted to this method of signaling.

### Reflecting Power of Stellite and Lacquered Silver.

Stellite has reflective qualities which are promising. The sample examined was more homogeneous and had a higher reflectivity in the visible spectrum than the samples previously reported upon.

In connection with the question of finding a substitute for the glass reflector used in searchlights and other apparatus (which problem was submitted by the War Department), an examination was made of the effect of ultra-violet light upon lacquered silver. It was found that the lacquer undergoes photochemical action which affects the silver and decreases its reflecting power.

### Protection of Moving-Picture Film from Heat of Lamp.

In certain work it is desired to stop the movement of the picture film in order to make an examination of the details of a single picture projected upon a screen.

As ordinarily used the moving-picture film is partly protected from injury by the intense infra-red rays from the lamp, because it is exposed to these rays for only an instant. Applying the information obtained in a previous investigation, the intensity of the infra-red rays was greatly reduced by using a dilute solution of cupric chloride which absorbs but little of the visible spectrum, but which is practically opaque to infra-red rays.

### Exclusion of Ultra-Violet Light from Buildings.

The problem was presented by the War Department to find a substitute for colored glass to exclude the ultra-violet solar rays from balloon hangars and from other buildings requiring such protection. Tests were made showing that varnishing plain glass with dilute asphaltum varnish is very efficient in absorbing the ultra-violet rays. A better method is to provide, a sort of Venetian blind, or louver of wide slats, painted buff to reflect the light into the building.

### Information Furnished on Radiometric Subjects—Conferences.

Information was given on various radiometric matters, such as, for example, photoelectric substances; reflectivity data; eye protective glasses; methods of making radiant-power life tests of mercury-vapor lamps; ultra-violet radiations used in life tests of fabrics; substitutes for expensive colored glass in balloon hangars; thermal radiodynamic devices for signaling; radiometric methods of detecting invisible hot objects; demonstration before a special naval board of this Bureau's thermal radiodynamic signaling apparatus.

### Publications on Radiometry.

The following publications on radiometry were issued during the past year:

Technologic Paper No. 93 (third edition, revised and enlarged); Glasses for Protecting the Eyes from Injurious Radiations; Scientific Paper No. 325, Spectroradiometric Investigation of the Transmission of Various Substances; Scientific Paper No. 330, The Decrease in Ultra-Violet and Total Radiation with Usage of Quartz-Mercury Vapor Lamps; Scientific Paper No. 338, Some Optical and Photoelectrical Properties of Molybdenite (in press); Technologic Paper No. 128, Effect of Solar Radiation Upon Balloons.

## INTERFEROMETRY.

**(The light wave used as a fundamental standard of length; variation of this standard length with the medium through which it passes; measurement of very small displacements; general development of interferometry.)**

### Thermal Expansion of Small Samples.

The expansion of small samples due to temperature changes is most accurately determined by methods that make use of the interference of light waves. A scientific paper describing the apparatus and method with which the expansion of a single pin, 10 millimeters long and 5 square millimeters in cross section, can be determined is ready for publication. The description of the apparatus and method for determining the expansion of three different samples simultaneously was published in the Journal of the Washington Academy of Science, May 19, 1919. Suitable temperature-control apparatus has been installed, so that expansion determination can be made with the temperature range —190° to 1,000° C. During the past year the thermal expansions of 85 samples of optical glass were measured over the temperature range 20 to 650° C. Several tests were made for different glass manufacturers. Other materials, such as invar, steels from which precision gauges are made, human teeth, and dental porcelains and amalgams, were investigated.

### Dimensional Changes of Dental Materials.

In connection with the Bureau's investigation of dental material, which was undertaken at the request of the Surgeon General's office, interference methods were employed to make measurements of dimensional changes of the materials. Changes of dimension usually takes place in porcelain and amalgam used in filling teeth for some time after they are made up. Measurements of these changes, commencing a few minutes after the material was prepared and extending over a period of from one to four days, were made on 90 samples. In order to determine the effect of temperature changes on fillings, the thermal expansions of teeth and different kinds of materials were investigated. It was found that the expansivity of the amalgams was about four times that of the teeth, while for porcelain it was about the same. The results of this investigation are ready for publication.

### Standardization of Precision Gauges.

Precision end gauges, which are steel blocks with two opposite faces plane, parallel, and a specified distance apart, are used as master gauges for precise mechanical work. These gauges are made so nearly perfect that it is impossible to determine their errors with any contact micrometric apparatus. Interference apparatus and methods have therefore been employed in the calibration of these gauges. During the past year several sets of gauges were calibrated relative to the standard light waves and a large number of other gauges were compared with the secondary standards. Seven thousand six hundred gauges manufactured at the Bureau and 3,500 from manufacturing companies were tested. Change in dimension with age and change in thermal expansivity, with the composition and heat treatment of the steel used, were found to be important factors in the reliability of precision gauges.

### DISPERSOIDS.

(Investigation of the physical properties of dispersoids, such as smokes, water supplies, biological fluids, gelatin films, etc.; preparation and specification of standard dispersoids; development and standardization of dispersoid constants, instruments, and methods of measurement; cooperation in the technical application of dispersoid information in other branches of Government, in science, and in the industries.)

#### Properties of Smoke.

The word "smoke" denotes the products of combustion forming a visible cloud of small particles. These may be either solid, as the carbon particles from a sooty flame, or liquid, as the vegetable-oil particles in tobacco smoke. Smokes are of military importance for screening purposes, and the attention of the French Commission, during their visit to the Bureau, was called to its great utility at the front.

During the war the Bureau was asked to cooperate with the Chemical Warfare Service in investigating the properties of toxic smokes. To do this most quickly and thoroughly the Bureau specialist worked with the research division of the Chemical Warfare Service. For the work of the gas-mask research section it was necessary to design a sensitive photometer for measuring the smokes which could be produced in this country. Two of these instruments, built by the American Standard Motion Picture Co., were completed when the armistice was signed. Some parts of the joint investigations with the dispersoid section of the service were published in the Journal of the American Chemical Society, volume 41, pages 312–329.

## 5. CHEMISTRY.

[Chemical composition and purity of material; chemical properties and constants, including researches upon methods of analysis, specifications for technical materials, and preparation of pure materials for standardization work for the Government and for industrial and scientific laboratories.]

#### Chemical Testing.

The number (18,436) of chemical tests made in the chemical laboratories during the year slightly exceeded that of the preceding year. Distributed by types of materials, they were as follows: Ferrous metals (irons and steels), 1,177; nonferrous metals, alloys, and coated metals, 960; cement and cement materials, 8,091; bituminous products (including creosotes, etc.), 1,129; varnish materials (including shellacs), 839; paint materials, 1,016; lubricants, 557; soaps, nondrying oils, and metal polishes, 674; inks and related office supplies, 673; balloon fabrics, 840; rubber, 906; leather, 421; textiles, 745; miscellaneous, 408.

The tests were made for very many Government bureaus and establishments and for States, municipalities, and private parties, as follows: Agriculture, 102; Commerce, 10,057; Navy, 737; Post Office, 474; Treasury, 525; War, 4,409; Panama Canal, 1,171; General Supply Committee of the District of Columbia, 533; U. S. Shipping

Board, 148; other Federal institutions, commissions, and committees, 220; State, municipal, and other institutions, 34; private parties, 26.

## Chemical Publications.

The following papers emanating wholly or in part frem the chemistry division were published during the year or are nearly ready for publication:

Zinc-Cyanide Plating Solutions, published in Monthly Review American Electroplaters' Society, volume 5, Nos. 11 and 12, and volume 6, No. 4, 1918.

Military Applications of Electroplaitng, published in Metal Industry, volume 16, page 498, 1918.

Notes on Black-Nickel Plating Solutions, to appear in Monthly Review American Electroplaters' Society.

Operation of Fluoborate Lead-Plating Baths, to appear in Review American Electroplaters' Society.

Lead Plating from Fluoborate Solutions, to appear in Transactions American Electrochemical Society.

Factors Governing the Structure of Electrodeposited Metals, to appear in Transactions American Electrochemical Society.

Report on Ladle Test Ingot Investigations, to be published as an appendix to the report of committee A-1, American Society for Testing Materials, 1919.

Electrolytic Resistance Method for Determining Carbon in Steel, to be published in Journal of Industrial and Engineering Chemistry.

Technologic Paper No. 118, Critical Study of the Ledebur Method for Determining Oxygen in Iron and Steel.

Technologic Paper No. 126, A Study of the Goutal Method for Determining Carbon Monoxide and Carbon Dioxide in Steels.

Scientific Paper No. 346, Oxygen Content by the Ledebur Method of Acid Bessemer Steels Deoxidized in Various Ways.

Scientific Paper No. 350, Equilibrium Conditions in the System Iron Oxide, Carbon, and Hydrogen in Relation to the Ledebur Method for Determining Oxygen in Steel.

Technologic Paper No. —, Investigations at the Bureau of Standards on Gases in Steel and on Deoxidation of Steel, also to appear in Bulletin Institute of Mining Engineers.

The Generation of Hydrogen from Ferrosilicon and a Solution of Sodium Hydroxide (Methods of Study), to appear in Journal of Industrial and Chemical Engineering.

The Generation of Hydrogen from Ferrosilicon and Sodium Hydroxide (Details of Experiments and Recommendations), published in Fourth Annual Report National Advisory Committee for Aeronautics.

The Use of Lime in the Generation of Hydrogen from Ferrosilicon and Sodium Hydroxide, published in Fourth Annual Report National Advisory Committee for Aeronautics.

The Effect of the Presence of Sodium Carbonate on the Generation of Hydrogen from Ferrosilicon and Sodium Hydroxide, published in Fourth Annual Report National Advisory Committee for Aeronautics.

The Use of Ultra-Violet Light for Testing Balloon Fabrics, published in Fourth Annual Report National Advisory Committee for Aeronautics.

Characteristic Exposure Tests of Balloon Fabrics, published in Fourth Annual Report National Advisory Committee for Aeronautics.

The Testing of Hydrogen for Balloon Fabrics, published in Fourth Annual Report National Advisory Committee for Aeronautics.

Cemented Seams and Rubber Cements with Reference to Balloon Construction, published in Rubber Age and Tire News, volume 4, page 421, 1919.

Balloon Fabrics and their Testing, published in Textile World Journal, volume 55, page 1047, 1919.

Scientific Paper No. —, Efflux of Gases Through Small Orifices.

Circular No. 81, Bibliography of Helium, also in Journal Industrial and Engineering Chemistry, volume 11, page 682, 1919.

Technologic Paper No. 131, Application of the Gas Interferometer to Gas Analysis.

Preparation and Testing of Pure Hydrogen, to appear in Journal of Industrial and Engineering Chemistry.

A Method for Determining the Permeabiliy of Balloon Fabrics, to appear in Journal of Industrial and Engineering Chemistry.

The Significance of Oxygen in Balloon Gas, to appear in Aviation and Aeronautical Engineering.

Technologic Paper No. —, New Forms of Combustion Apparatus for Use in Gas Analysis, to appear also in Journal of Industrial and Engineering Chemistry.

Technologic Paper No. 128, Effect of Solar Radiation on Balloon Fabrics.

Automatic Methods of Gas Analysis Depending Upon Thermal Conductivity, in preparation.

The Permeability of Rubber to Various Gases, in preparation.

Comparative Tests of Palau and Rhotanium Ware as Substitutes for Platinum Laboratory Utensils, published in Journal Industrial and Engineering Chemistry, volume 11, page 570, 1919.

Technologic Paper No. 136, the Determination of Free Carbon in Rubber Goods, also in Journal of Industrial and Engineering Chemistry, volume 11, page 33, 1919.

Mercerization of Cotton Yarns, to appear in Textile World Journal.

Analyses of Different Tannages of Strap, Harness, and Side Leathers, to appear in Journal American Leather Chemists' Association.

Technologic Paper No. 138, Effect of Glucose and Salts on the Wearing Quality of Sole Leather.

Technologic Paper No. 138, Wear Resistance of Sole Leather.

Technologic Paper No. 145, The Direct Determination of Rubber by the Nitrosite Method.

Metallic Coatings for Rustproofing Iron and Steel, published in Chemical and Metallurgical Engineering, volume 20, page 458, 1919.

Technologic Paper No. 140, Constant Temperature Still-Head for Light-Oil Fractionation, to appear also in Journal Industrial and Engineering Chemistry.

Circular No. 62 (revised), Specifications for and Methods of Testing Soap.

Circular No. 82, Specification for Linseed Oil—Raw, Boiled, and Refined.

Technologic Paper No. 132, The Mechanical Properties and Resistance to Corrosion of Light Alloys of Aluminum and Magnesium with Copper, with Nickel, and with Manganese.

Circular No. 80, Protective Metallic Coatings for the Rustproofing of Iron and Steel.

## PHYSICAL CHEMISTRY.

(Preparation and purification of materials required in physical measurements of precision—for example, refrigeration materials, calorimetric samples, materials for standard cells, and for density determinations; determination of certain physical constants and development of methods for their exact determination.)

### Refrigeration Materials and Problems.

In extension of the work of the previous year additional samples of pure ammonia were prepared for the making of vapor-pressure determinations in the heat division. The presence of extremely minute quantities of permanent gas affects these measurements considerably, particularly the ease with which equilibrium is attained. The method of testing for small quantities of permanent gas has proved very useful in this work and in that of the density of the gas (or weight of a normal liter) as a criterion of purity. Little work on ammonia remains to be done, and a publication is in preparation on the purification and physical properties of ammonia which will be quite extensive in scope.

The plant installed for a study of gas formation in compression systems of refrigeration has been in operation for several months, and a report upon the subject is contemplated for the next meeting of the American Society of Refrigerating Engineers.

### Purification of Materials for Special Purposes.

*Standard samples.*—Considerable work has been done on the renewal of benzoic acid and naphthalene as standards for calorimetry. The former, of satisfactory quality, was unobtainable during the war, but now rather large quantities of both raw materials are available from which to prepare the pure standards from time to time. Facilities have been lacking heretofore for the purification of quantities large enough to last for more than a few months; but the installation of new and larger equipment will permit of preparing stock to last for at least two years.

*Mercury.*—Mercury purification is now on practically a routine basis. Aside from supplying the needs of the Bureau, material has been furnished to the Geological Survey, the Weather Bureau, and the Magnetic Laboratory of the Carnegie Institution. Considerable work was done on methods of testing mercury as to purity, particularly by the measurement of its electromotive force.

*Methane.*—Supplementing work of the previous year, several additional samples of pure methane were prepared for the determination of its thermal properties by the heat division. The preparation of this gas requires a very elaborate arrangement of apparatus and the continuous attendance of operatives for as much as 48 hours at a time.

*Methyl alcohol.*—Considerable attention was given to the purification of methyl alcohol for use in determinations of density by the division of weights and measures. A series of samples from various sources was prepared and tested for purity by use of the critical solution-temperature method.

### Critical Solution Temperature Work.

Experimental work is being conducted on the quantitative application of the critical solution-temperature phenomenon (1) as a criterion of the purity of chemical substances; (2) to the determination of the composition and constituents of petroleum products, especially gasoline; (3) to the determination of the quantity of water absorbed by gasoline, transformer oils, and other products which dissolve small quantities of water; (4) the miscibility relations of the alcohols and hydrocarbon mixtures, such as kerosene, as bearing on the utilization of the higher boiling hydrocarbons as internal-combustion motor fuels.

The fundamental data necessary to the application of this method to the problems listed above are the equilibrium relations in the various binary systems, showing two liquid layer phenomena with an upper critical solution temperature (the temperature above which two liquid layers can not exist). Methyl alcohol, ethyl alcohol, aniline, nitrobenzene, and formic acid are substances which show these phenomena with certain compounds and types of compounds forming the constituents of the lower-boiling petroleum products. The change in the value of the critical solution temperature of these substances with various types of hydrocarbons and with various members of the same series promises to contribute materially to our knowledge of the constituents of gasolines and the analytical methods which can be applied to this very complicated problem. The data obtained from these solubility curves are also available for purity tests of different samples of the various substances involved. Methyl alcohol used in this work has been checked as to purity with pure samples of carbon disulfide. The equilibrium relations between these two substances have been determined, as well as those in the system ethyl alcohol—carbon disulfide. Several samples of commercial aniline have been tested and purified and used in the examination of gasolines. In addition to the characterization of types of gasolines by this phenomenon, it is found that the great effect of water on systems of this type can be utilized in determining small quantities of water and the solubility of water in liquids dissolving water sparingly. Before applications of this kind can be made it is necessary to determine the effect of known quantities of water added to the system. The work is progressing mainly toward the acquisition of the fundamental data necessary preliminary to the practical application of the method to more specialized engineering or technical problems.

*Determination of Physical Constants.*—It is aimed to provide equipment and permanent arrangements for the precise determination of some of the more commonly used physical constants, particularly those useful to organic chemists in the identification of compounds. Thus far most attention has been paid to freezing-point determinations of mixtures as well as single substances; for instance, of various samples of motor fuels. It is expected to extend the work to the determination of boiling points, refractive indices, and densities.

*Glass-to-Metal Joint.*—A glass-to-metal joint has been devised and used very successfully in work with gases under high pressure. The joint is tight under a complete vacuum and is resistant to very high pressures, facts which make it very useful in laboratory work in physical chemistry.

### Atlas of Heterogeneous Equilibria.

In the report for 1916 reference was made to a proposed atlas of heterogeneous equilibria. Work on this compilation has progressed satisfactorily, and the information so far accumulated has been very useful in the work of the chemistry division and in the correspondence referred to it.

## ELECTROCHEMISTRY.

(Electrodeposition, including electrotyping and electroplating, the latter including investigations of zinc, lead, nickel, copper, silver plating, etc.)

### Electroplating.

During the first half of the fiscal year the section was actively engaged in problems connected with the electroplating of military supplies. Such problems were very numerous and varied and involved a great amount of travel and conference with manufacturers and military officials. While in most cases the military applications of plating were, or appeared to be, incidental, the prompt delivery of materials and the durability of the products during storage and transportation or in field use, were often determined by the success or failure of the plating operations. The need for definite information was emphasized by the almost absolute lack of commercial standards or specifications, in consequence of which fact delays and confusion were not unusual. Through conferences with manufacturers and military officials this Bureau was able to suggest tentative specifications which were mutually satisfactory. In general, in such specifications the purpose was to give as much latitude to the manufacturers as would permit satisfactory products, and also to unify and systematize, so far as possible, the requirements of different military branches for similar products or for materials subject to similar use and exposure.

The research work carried on at the Bureau was devoted principally to meeting immediate military needs. Consequently it was not possible to conduct any exhaustive or detailed investigations. Nevertheless, much information of value to the plating industry was obtained, and an acquaintance with platers and manufacturers and their needs was secured which will, it is believed, be of great value in further research in this field.

The principal military applications of electroplating which were investigated at the Bureau were as follows:

*Lead Plating.*—This had very little commercial application prior to June, 1918, at which time a demand arose for lead coatings in connection with gas shells. Within a few months a considerable number of plants were prepared to carry out this operation, using either fluosilicate or fluoborate solutions. In view of certain advantages possessed by the latter solutions, they were investigated by this Bureau, and working directions were furnished to manufacturers. Other applications of lead plating were the bringing up to weight of underweight shells, of which many thousands were thus salvaged, and, to a less extent, the lining of chemical equipment. Possible commercial applications of lead plating are being investigated.

*Black Nickel Plating.*—This operation was very extensively used to produce a black finish upon military equipment. The formulas in commercial use were very involved and frequently unsatisfactory. As a result of investigations at the Bureau, simple satisfactory formulas were recommended.

*Zinc Plating.*—In view of the fact that zinc is the only metal that furnishes intrinsic protection against corrosion of steel, zinc coatings have proved very valuable. Of the three methods of producing satisfactory zinc coatings—viz, hot dipping, sherardizing, and zinc plating (electrogalvanizing)—the latter is frequently most convenient, especially for small parts, or those which are threaded or dimensioned or those having previous heat treatment and which might be injured by reheating. It was found that entirely satisfactory zinc plating can be conducted in either cyanide or sulphate solutions. Results of the investigation of the cyanide solutions have been published, and the work on sulphate solutions is still in progress.

There were many minor military problems and applications of electroplating submitted for consideration, all of which showed the need in this industry for better definition of methods of plating and of testing plated products. Throughout in these investigations the Bureau has had the active support and cooperation of the American Electroplaters' Society, three of whose members, at considerable financial sacrifice, devoted their entire time to this work. With the cessation of hostilities and the consequent reduction in military demands and financial support it was no longer possible to retain any considerable staff upon electroplating problems. In view, however, of the importance and far-reaching applications of electrodeposition, arrangements have been made to devote a limited sum from the industrial research fund to these investigations during the fiscal year 1919–20. In addition, it is hoped that some financial support may be furnished by manufacturers interested in plating.

While these investigations will be conducted with a view to securing information of industrial value and to publishing it in a form useful to practical platers, experience has shown that permanent and far-reaching progress in this field must involve fundamental studies of electrodeposition, requiring the services of persons especially qualified in physical and analytical chemistry and metallography, and at least one person thoroughly acquainted with the present methods and needs of the electroplating industry. The possible scope of work in this field may be judged by the many kinds of electroplating which find application in the most varied industries. Thus, in addition to the lead, zinc, and black nickel plating previously referred to, nickel, silver, brass, copper, gold, and tin plating are all extensively employed. Progress in this field will involve a considerable annual expenditure, which, however, is fully warranted by the importance of electrodeposition in its varied applications.

## METALLURGICAL CHEMISTRY.

**(Preparation of metals and alloys required in connection with metallurgical investigations and special methods of analysis for such products.)**

The work done by the chemistry division, in connection with metallurgy, is reported under "Chemical metallurgy" (p. 558).

## GAS CHEMISTRY.

**(Methods of preparation, purification, analysis, and testing of gases, including fuel and illuminating gas, and special gases, such as hydrogen, oxygen, nitrogen, and argon.)**

The two most important and extended lines of work carried on by the gas section during the past year were (1) the testing and investigation of the properties of balloon fabrics and (2) the development of a method of automatic gas analysis, the possibilities of which have not heretofore been appreciated. The other investigations carried out by the section, in most of which the Bureau served the military and naval departments in the capacity of a consulting chemical engineer, were of too varied a nature to permit classification. Thirty-two reports and publications were made or are in preparation.

### Balloon Fabrics.

The testing of balloon fabrics for permeability and lasting qualities has continued along the lines so well established during the preceding year. The volume of work has been very large, not only during the war, but since the signing of the armistice, because of the extensive experimental program of the Navy. The total number of fabrics tested during the year was 710, 1,520 individual tests of various kinds being involved.

In addition to this regular testing work, investigations were made along the following lines:

1. The permeability of various materials to helium. An investigation to determine the suitability of the present fabrics for making helium balloons and, if possible, to develop improved fabrics for the purpose. The properties of ordinary fabrics have been well

ascertained, but no improved fabric for use with helium has resulted.

2. The permeability of rubber to various gases. An investigation made to determine not only the usefulness of rubber as a container for various gases, but also to shed light on the mechanism of permeability.

3. The relation of the thickness of rubber films to permeability.

4. The relation to permeability of the partial pressure of a gas and the nature of its diluent.

5. The relation of temperature to the permeability of rubber films. The principal significance of (4) and (5) is in connection with testing methods.

6. The effect of solar radiation on balloons. This investigation included the heating of the fabric and the temperatures in various parts of the balloon, convection losses from balloons in flight, the effect of radiation on the lasting qualities of the fabric, the protection of the fabric from injurious effects, and the effect of pigments in fabrics upon the changes of balloon temperature and the visibility of balloons.

7. The microscopic examination of fabrics. This work, carried out upon transverse sections, proved of great assistance in connection with a number of problems, but particularly in connection with cements and seams.

8. Acidity tests of fabric. It was found that a part of the deterioration of the fabrics in service was caused by sulphuric acid formed by the oxidation of the sulphur used in compounding the rubber.

9. The relation of permeability to the thread count of the fabric. Shortly before the signing of the armistice this problem assumed considerable importance, because the production of balloon fabrics at that time appeared to be limited by the possible output of the machinery available for the manufacture of the very fine fabrics used for the purpose.

10. The deterioration of fabrics under tension. This investigation was intended to supply information relative to the abnormally short life of dirigibles in service. No conclusive results were obtained.

11. A comparison of the American and Italian methods of making life tests of fabrics. This investigation is still continuing. Thus far there is no indication that the Italian method (exposure to the weather with hydrogen on one side) is superior to the American methods.

12. A comparison of the English and American methods for making permeability tests.

13. A study of exposure tests of fabrics at Washington and Pensacola. A study of the significance of various meteorological conditions in the deterioration of the fabrics.

14. The effect upon balloon fabrics of impurities in hydrogen and of contact with metal fastenings. These tests showed what metals could be safely used in balloon construction, and indicated that the elimination of the last traces of gaseous impurities from hydrogen is unnecessary.

15. A study of balloon seams and rubber cements for making seams. This work gave some very valuable information regarding the construction and causes of failure of balloon seams.

16. The development of two more rapid methods of making routine permeability tests which should be of considerable importance in case sudden rapid expansion of balloon production is again required.

17. The determination and partial elimination of a source of error in making permeability tests due to the passage of gas between the layers of fabric.

The above investigations were all carried out in the closest cooperation with the Army, the Navy, and the manufacturers; and since none of these parties had any adequate facilities or personnel for the study of such problems, the work done by the bureau may be regarded as of fundamental importance. Many reports and publications on these subjects have been made or are in preparation.

**Automatic Gas-Analysis Apparatus.**

Without doubt, the work of most importance to American industry accomplished by the section during the year was the development of some simple and extremely sensitive apparatus and methods for the automatic analysis of gases. This work was undertaken at the request of the Nitrate Division of the Ordnance Department in connection with the analysis of the complex gas mixtures employed in the synthetic manufacture of ammonia. Apparatus was designed and the measuring instruments had been constructed and calibrated for the chemical control of the big plant at Sheffield, Ala., when the armistice was signed and work at that plant ceased. A smaller apparatus has, however, been constructed for the use of the experimental plant at Arlington and is now in use at that place.

Apparatus was also constructed for recording the percentage of helium in the preparation of that gas for balloon purposes and has been installed in the fractionating plant at Petrolia, Tex. This apparatus, after installation, was also adapted for recording the composition of the raw gas entering the plant. Similar apparatus for making and recording 12 continuous analyses simultaneously is now under construction for use in the big helium plant at Fort Worth.

This type of apparatus has been tried out successfully for so many purposes that the following list of the determinations possible by this method seems justified: (1) Practically any binary mixture of which the constituents are known. (2) Practically any easily absorbable constituent of a gas mixture containing no other constituent which reacts with the reagent used. (3) Any single combustible gas in air or oxygen. (4) Oxygen, hydrogen, nitrogen, carbon monoxide, and carbon dioxide in mixtures containing these gases only. (5) Total carbon or total carbon, except carbon dioxide, in most gas mixtures of industrial importance. (6) Oxygen required to burn any ordinary reducing gas mixture or oxygen required to burn all the reducing constituents except hydrogen. (7) Hydrogen or helium in any ordinary mixture. Many other combinations are, of course, possible. A single electrical measuring instrument or recorder can be easily adjusted to read any one of several such analyses on the same decimal scale or to read directly a linear function of the composition, such, for instance, as the permeability of fabrics in suitable units. The apparatus can also be made to automatically control various mechanisms. The analysis of flue gases, mine air, blast-furnance gases, and many industrial gases can probably be put on a recording basis with apparatus much superior to any now in use for similar purposes.

One of the foremost instrument manufacturers in the country is to undertake the manufacture of this apparatus in the near future.

### Miscellaneous Problems.

1. A determination was made of the limits of inflammability of mixtures of hydrogen and helium, particularly when issuing from orifices of various sizes. A considerable amount of work was also done on the analysis of helium mixtures in connection with the numerous problems involving that gas.
2. The bibliography of helium literature was revised.
3. A technical report was rendered on the practicability of producing ammonia as a by-product in the separation of helium from natural gas, according to a method proposed by the engineering laboratory of the United States Naval Academy.
4. Analyses of the exhaust gases from airplane engines were made throughout most of the year for the gas-engine section.
5. A considerable amount of work was done upon the selective combustion of carbon monoxide in gas analysis, and upon the determination of carbon dioxide, of water, and of ammonia in very small amounts in gases by electrolytic conductivity methods. Some of the methods studied give promise of usefulness when there is opportunity to develop them further.
6. Tests were made at Langley Field to determine the performance, as to yield and purity, of the large hydrogen plant installed there. Acceptance of the plant and the compensation paid the contractor was based on these tests.
7. A considerable amount of time was devoted to cooperative tests with the Bureau of Aircraft Production upon the ignition of balloons by incendiary bullets.
8. A number of useful pieces of apparatus and methods of laboratory work were developed. The most important of these is a form of bridge for measuring directly the difference of conductivity of two electrolytes.
9. A determination of the temperature of inflammability of organic material in contact with sodium nitrate was made for the Railroad Administration. This problem arose in connection with the storage of this material in warehouses and docks.

## REAGENTS AND APPARATUS.

(Study of methods of testing reagents and apparatus to be used in chemical analysis, including study of chemical glassware, porcelain, platinum, and platinum substitutes.)

### Chemical Reagents.

Owing to the limited force, abnormal conditions, and the miscellaneous tests made for the Military Establishments, little progress has been made in the study of the methods of analysis of the so-called "analyzed reagents." Most of the work has consisted in the testing of reagents purchased for the use of the laboratories of this Bureau. This work indicates that there is room for improvement in most, if not all, of the reagents tested. This study having been taken up in cooperation with the American Chemical Society and the manufacturers, a report has been submitted to the chairman of the committee on analyzed reagents of the American Chemical Society, and manufacturers advised of the discrepancies between the printed labels and the actual findings. A synopsis of this report was published in the Proceedings of the American Chemical Society, 1919. As the quality of chemical reagents is of direct interest to all scientific and industrial laboratories, and indirectly affects all users of the products of the industries, means should be provided for prosecuting this work in a systematic way.

### Platinum.

The research upon the chemical and physical properties of the platinum metals has been continued. The analytical methods given in the literature have been studied and the information so obtained applied in the examination of various samples submitted for test. The preliminary purification of platinum, palladium, and iridium has been completed, and the study of the physical properties of the pure metals will soon be taken up. Analyses were made of platinum gauzes for use as catalysts in the oxidation of ammonia by the Nitrate Division of the Ordnance Bureau. Owing to the price of iridium and the necessity for conservation, the Bureau of Aircraft Production had prepared platinum-iridium alloys containing varying percentages of iridium to be used in the manufacture of magneto contact points. Service tests and chemical analyses were made by this Bureau. The analyses showed that only about 50 per cent of the iridium content claimed was found in each case. The standard platinum-iridium alloys in general use contain 15 to 20 per cent of iridium. This work was discontinued on the signing of the armistice.

Negative tests of reputed platinum ores were made at the request of Government offices, analyses of various platinum metals were made for the United States assay office, and miscellaneous tests made and reports rendered for military branches of the Government.

Through the cooperation of the nitrate division of the Ordnance Department, United States Army, the Bureau has received for use in research 72 ounces of platinum residues from the United States assay office. Unfortunately, the important metal rhodium was found to be almost lacking in these residues.

The United States assay office, continuing its cooperation of the previous year, has made for the Bureau many vessels and articles of platinum and some of gold.

### Platinum Substitutes.

The shortage of platinum shortly before and during the war aroused the interest both of commercial organizations and the public in general. Quite a number of "platinum substitutes" were developed and samples submitted to this Bureau for test. Most of this work was done for the platinum section of the War Industries Board. The substitutes proposed for platinum were of two kinds; those composed of base metals, and alloys of the noble metals. No base metal substitute was submitted which approached platinum in general usefulness or was suitable for laboratory operations. Two base metal alloys were examined which were found suitable for the purposes for which they were designed. One was an alloy very resistant to nitric acid and submitted by the nitrate division; the other could be used for electrical contact points under a limited range of conditions. In one case steps were taken to suppress wildly extravagant advertising. Of the noble-metal alloys two were examined, known as "palau" and "rhotanium." Both are alloys of gold with relatively small amounts of palladium. These were tested in conjunction with the metallurgical division and were found suitable substitutes for platinum in numerous operations in the chemical laboratory.

### Miscellaneous Tests.

Various miscellaneous tests were made for military and other offices, among which were (*a*) enamel ware, (*b*) lead, barium, and borosilicate optical glasses, (*c*) aluminum sulphate (inspection and sampling of a 500,000-ton lot for the Panama Canal).

## ANALYTICAL METHODS AND STANDARD SAMPLES.

(General methods of chemical analysis, with special reference to methods of standardization; preparation and analysis of standard samples of iron, steel alloys, ores, chemicals, etc.)

### Standard Analyzed Samples.

The number of standard samples called for during the fiscal year 1919 was 4,944, an increase of 108 over the previous year. The distribution was as follows: Irons and steels, 3,627; brass, 93; ores, 307; sodium oxalate, 325; naphthalene, 87; benzoic acid, 108; sucrose, 95; dextrose, 16; metals for melting points, 154; cement for testing sieves, 132.

The greatly increased calls for standard samples during the war left the Bureau with a much-depleted stock. This necessitated a curtailment of the distribution. In this connection it should be pointed out that the money value of the samples issued was more than twice the total appropriation for the work, namely, $4,000. Even with the fund available for the fiscal year 1919—namely, $5,000—it will be impossible to keep up the stock of samples already listed. The preparation of samples has been confined entirely to the renewal of the stocks of those listed.

The private enterprise in England mentioned in the last annual report requested the Bureau to cooperate in the analysis of a standard sample of chrome-vanadium steel, and to secure the cooperation of two outside analysts.

### Determination of Tungsten, Molybdenum, Zirconium, and Uranium in Ores and Metallurgical Products.

Continuing the cooperative work referred to in the last annual report, methods have been worked out for the determination of tungsten, molybdenum, zirconium, and uranium in metallurgical products and in ores of the three first-named metals.

### Miscellaneous Researches.

In addition to the above researches a number of others have been carried out, which served to clear up obscure points in analysis, namely, precipitation of zirconium as phosphate, volatility of phosphoric acid upon fuming with sulphuric acid and fusion with alkali pyrosulphate, determination of small amounts of aluminum in presence of large amounts of zinc, determination of small amounts of calcium in presence of large amounts of magnesium, study of temperatures obtainable with the ordinary types of laboratory burners, behavior of manganese and vanadium in the precipitation of iron and aluminum with ammonium hydroxide, according to the procedure of Blum.

## LUBRICATING OILS, RUBBER, PAPER, TEXTILES, INK, AND GLUE.

(Chemical analysis and investigations of oils, rubber, paper, textiles, ink, glue, airplane dopes, etc., with special reference to meeting particular requirements.)

### Airplane Dopes.

After the Signal Corps established its own laboratory in Pittsburgh, Pa., work was continued for the Bureau of Construction and Repair, Navy Department, not only until the signing of the armistice, but up to the present time. Numerous trips were made to manufactories of dopes and of airplanes, as well as to aviation fields, in the interest of the Navy.

Early in this calendar year the Department of Military Aeronautics, which had taken over the aviation program of the Signal Corps, found it advisable to return to the Bureau for assistance in the preparation of a lengthy report on foreign practice in doping and related matters. Part of the statements made by military observers abroad were of such doubtful reliability and so open to question that this Bureau was asked to test many of them by laboratory experiments.

### Chemistry of Leather.

Full details of the Bureau's work on leather, including that of the chemistry division, are given in the report entitled "Leather" (p. 524).

### Chemistry of Rubber.

Full details of the Bureau's work on rubber, including that of the chemistry division, are given in the report on rubber (p. 520).

### Chemistry of Textiles and Commercial Dyes.

Full details of the Bureau's work on textiles and commercial dyes, including that of the chemistry division, are given in the report of the textile section of Division VII (p. 527).

### Pure Dyes.

A great deal of time was devoted to the preparation of about 30 carefully made and purified dyes. This was done in connection with the projected development of a comprehensive method for the identification and analysis of dyes by spectroscopic measurements. Commercial dyes can not be used to obtain the fundamental data, because they are rarely single, pure substances, but generally contain colored organic impurities. Different salts of metals are also frequently admixed. It is obviously impossible to determine the character and intensity of color of the dye in such a mixture.

### Camouflage.

A statement of the work on dyed fabrics and screens for camouflage and secret signals appears in the report of Division IV.

**Photographic Sensitizers.**

One of the most valuable dyestuffs for sensitizing photographic plates to certain portions of the spectrum is dicyanin. This is a German product. Very little has been published about its chemical nature or the method of preparing it, and that little is probably misleading or lacking in some important detail. Attempts to produce dicyanin led to the discovery of a dye which is in some respects superior to it.

**Chemistry of Inks.**

*Writing and Copying Inks.*—A great many writing and copying inks were tested to assist the General Supply Committee and the Post Office Department in awarding contracts, and also to check deliveries made by contractors. There was evident an increasing tendency to manufacture inks from Prussian blue. This color is very permanent under some conditions, but has the disadvantages of not turning black and of being readily removable by a simple chemical treatment.

The most suitable inks for permanent writing contain iron gallotannate. On the paper this soon oxidizes to an intense black, although the writing is at first very pale. To get around this, a suitable dye is always used. For a considerable time after the supply of German dyes was exhausted American ink manufacturers had great difficulty in getting suitable dyes. The Bureau learned where satisfactory colors were made, and was thus able to help more than one ink manufacturers to improve his product.

*Ink Tablets and Powders.*—For many years various brands of tablets and powders for making writing ink by simply dissolving them in water have been on the market. They are more convenient than ink in liquid form, because they occupy so little space in shipment and storage; they can not freeze and break the bottles; they keep indefinitely; and they can be sent safely by mail. For these and other reasons the Army sent many thousands of tablets and powders abroad. The same reasons appeal to the Post Office Department, which supplies post offices throughout the country from Washington.

Until recently these powders and tablets have been made of "aniline," or, more correctly, synthetic, dyes. Such inks can not have sufficient permanence for record inks, and for that reason the Bureau has consistently refused to recommend them for use by the Government departments.

Red and other colored inks are necessarily made from dyes. It is immaterial whether these are put on the market in solid or liquid form.

Within the past year a few brands of gallotannate of iron tablets have been tested by the Bureau. Some of these were of a fairly satisfactory quality, but others were not only turbid when freshly dissolved, but the ink so prepared deposited large quantities of a thick, gummy sediment in a few days. Properly made liquid inks give very little sediment, because enough hydrochloric or other mineral acid is added to keep the iron compounds in solution. These acids, being liquids, can not be used in powders and tablets. The Bureau found that solid organic acids such as oxalic, or acid salts such as sodium bisulphate, can be used with success. This information was passed on to manufacturers of this type of ink.

*Concentrated Inks.*—Possibly owing to the difficulty of making suitable ink powders and tablets, some manufacturers have recently placed concentrated inks on the market. If properly made and not too greatly diluted, there is no reason why they should not be used for permanent records.

*Indelible Inks.*—A considerable quantity of indelible ink was used by various branches of the military organization for marking blankets, bales, etc. A great variety of materials was used in making these inks. By laboratory tests and by washing in a commercial laundry it was learned that a dye of good quality, dissolved in cresol, made the most permanent ink.

*Miscellaneous Inks.*—Among other classes of ink tested were the following: Stamping, drawing, and stenciling inks, and those to be used with canceling machines, duplicators, and hektographs.

*Typewriter Ribbons.*—Many ribbons for use on typewriters, as well as similar ribbons for time recorders, adding and computing machines, etc., were examined and tested. The quality of the fabric, the amount of ink, and the permanence of the writing were all considered in making the tests.

*Carbon Papers.*—Comparatively few carbon papers were received for test. The weight and quality of the paper, and the nature and amount of the coating were determined.

### Printing Inks.

The Bureau made only a few analyses of printing inks, but much time was spent in devising a method for determining the properties known to printers as "tack," "length," or "shortness," and "carrying power" of vehicles, the oil absorption of pigments, and the rate of setting vehicles and inks. By this method the results are expressed numerically and duplicate determinations give closely concordant figures.

Some progress has been made in correlating the data obtained in the laboratory with the behavior of the inks on the press, but many phases of the subject remaining to be investigated before the work can be regarded as complete.

### Printers' Rollers.

Printers' rollers are made of glue, water, and molasses or glycerol. A difficulty with rollers made with cane molasses is that they can not be melted and recast after they have become hardened in service. The Bureau devised and patented a method of using specially prepared beet molasses instead of cane molasses. The behavior of these rollers in service shows that they can be used much longer than the other without hardening. They can also be remelted.

The patent (United States 1,284,172), issued November 5, 1918, was dedicated to the public.

### Glue, Mucilage, Paste.

About 100 samples of glue, mucilage, and paste were tested for the Government.

### Miscellaneous.

Among the minor items in which the section was interested were: Paper boxes for shoe polish, safety matches, linoleum pastes; examining mangrove roots for tannin and dyestuffs; examining morinda roots for dyestuffs; preparing inks for recording instruments and for use in connection with the etching of graduated glassware; preparation of a liquid for use on mimeograph stencils; bleaching fresh-water pearl buttons, etc.

### Examination of Materials for the Steamboat-Inspection Service.

The Steamboat-Inspection Service depends upon the Bureau not only for the testing of goods that may possibly be prohibited on passenger steamers but also for options as to the propriety of carrying chemicals and other similar substances.

The Bureau agrees with the Service that the existing Federal law (Sec. 4472, R. S.), which was passed 45 or more years ago and which has been amended several times, is self-contradictory and hampering to foreign trade. The Steamboat-Inspection Service and the Bureau of Standards independently made recommendations to the Secretary of Commerce that steps be taken to have this old statute replaced by one abreast of the times. Their suggested outlines for a new law were surprisingly alike.

## METALS, CEMENT, AND BITUMINOUS MATERIALS.

(Chemical analysis of metals; including iron, steel, nonferrous metals, alloys, such as brass, type metal, and solder; coated metals, such as tin plate and galvanized metals; lime plaster, cement, concrete, bituminous materials, including tars, asphalt roofing papers, roofing felt, etc.)

### Chemical Work on Metals and Alloys.

In addition to a large amount of routine testing of metals and alloys, much attention has been given to trying out and improving methods of chemical testing. Many tests were made for the purpose of supplying information to other divisions of the Bureau to aid in determining the most suitable materials for various military needs and to explain causes of failure. A number of special metals and alloys were analyzed.

An exposure test to determine the relative resistance to corrosion of uncoated sheet iron and steel was made in cooperation with the Post Office Department. Sheets were exposed on post offices in several large cities and subsequently compared at the Bureau. The use of sheet steel containing from 0.15 to 0.25 per cent of copper was recommended.

### Protective Metallic Coatings.

For various branches of the War and Navy Departments tests were made of numerous samples of metal rustproofed by different companies and by different methods.

The method of stripping zinc-coated metal referred to in last year's report—by means of sulphuric acid and sodium bichromate—has been critically examined and found to be unsatisfactory for commercial application. However, careful application of the test will give a fair estimate of the amount of zinc applied.

Salt-spray tests on aluminum alloys, started in 1917 in cooperation with the metallurgy division, were completed and reported upon in Technologic Papers Nos. 132 and 139.

Corrosion tests were made for the Engineering Division of the Ordnance Department on German silver and "aluminized" (tin-coated) steel hinges for meat cans. Considering the advantages of using steel, the tin-coated hinges were regarded as superior to those of German silver, but, in order to conserve tin, zinc-coated steel was recommended.

A test for pinholes in lead plating was developed to indicate a satisfactory lead lining for gas shells. This consists in immersing the plated steel in a solution containing 1 per cent of sodium ferricyanide and 2 per cent of sulphuric acid. Pinholes are indicated by the appearance of a characteristic blue precipitate.

**Bituminous Materials.**

*Roofing.*—The preparation of a standard specification for prepared roofing discussed in last year's report became a reality; in conjunction with the War Trade Board the specification was prepared and adopted. It included methods for inspection, testing, and instructions for inspectors; but with the cessation of the war the need of maintaining a corps of inspectors at the plants passed. Millions of squares of roofs obtained under this specification but laid under high pressure failed in many cases to be satisfactory; leaks developed which at first were blamed on the quality of the roofing used, but from inspection it was evident that the fault was with the manner of laying and not the material. The development of a satisfactory bituminous cement to repair the leaks enabled effective repairs to be made at a very moderate cost.

Specifications for slate-surfaced and asphalt shingles were also prepared, but the specification for built-up roofing, which is required under normal conditions, still remains to be developed, nor has it been possible to make a systematic inspection of the repaired roofs which have been laid, and it will be unfortunate to lose this information, which is necessary to improve the specifications which have been in use.

*Interior coating for steel ships.*—The specification for the coating of the interior of steel ships prepared originally for the United States Navy Yard at Philadelphia, and extended to apply to the bituminous enamel used on the lock gates at Panama, has been modified by restricting the quantity of mineral filler and controlling the consistency of the development of a test which measures this condition so as to improve the specification. This material has also found a use for steel ships being built by the Emergency Fleet Corporation.

*Interior coating for steel shells.*—The Ordnance Department of the Army asked for a specification for an inside coating for high-explosive shells and shrapnel. This coating should be free from any lead or managenese compounds; it should not dry hard, but remain tacky, so as to bond with the molten T. N. T. with which the shells were charged; and should not have any effect on the efficiency of the explosive. A Gilsonite fluxed with a soft Bermudez asphalt and thinned with a light volatile petroleum product appeared to give a satisfactory coating.

*Coating for grenades.*—The Ordnance Department also desired a coating for hand and rifle grenades. Hand and rifle grenades require a coating which will dry hard on a greasy surface, as it is not practicable to clean them after machining. A hot coal-tar pitch of relatively low penetration and high melting point was being developed for this purpose when the closing of hostilities practically stopped production of grenades.

### Coatings for Concrete Ships.

The concrete ship was a new venture and required special treatment. A ship is subjected to great and various strains and can not be made perfectly rigid. Concrete is usually considered a rigid material, but in fact it is elastic, and if it is properly reinforced it will stand much distortion without failure. Small hair cracks may develop, and it was the problem to cover the outside of the structure with an elastic waterproof membrane which would bridge such small cracks. The coating must not be affected by water, must not flow when subjected to the pressure of the water when the vessel runs at maximum speed, and must present a suitable surface for the application of antifouling, boot-topping, and camouflage paints over it. All of these conditions were considered, and a number of products tested in an effort to obtain one which seemed to best meet conditions of service. Two compositions were recommended, and further work is in progress.

Another problem in connection with the concrete ships was to provide an inside coating for oil tanks. Many of these ships were to be used as oil tankers for the transportation of a variety of crude and refined oils. The problem was complicated by the presence of water in the oil, and also by the fact that these tanks might frequently be filled with water as ballast on return trips, so the coating must be resistant to both water and oil. After an extended investigation it was recommended that a Chinawood oil-resin varnish, commonly called " spar " varnish, was the best available material. This, however, is not entirely satisfactory, and nothing better has yet been tried. It is believed that failures have been more due to faulty methods of application and to expecting more than could possibly be obtained from a paintlike coating than to actual inferiority of material used. Probably the life of the best coatings available will always be short.

### Marine Glue.

In an attempt to meet the requirement of the Naval Hydroplane Service for a marine glue for pontoons the original Jeffreys marine glue, made in England, was examined, as well as the present foreign product and domestic substitutes, in the hope that a material might be developed which would make this country independent of foreign production. Neither the present foreign product nor the domestic substitutes were found to be entirely satisfactory, but it was found that Manila or similar varnish resins, with pine tar and rubber, thinned to proper consistency, also blown Mexican or Texas asphalts with gilsonite and a mineral filler thinned to proper consistency were satisfactory.

### Linoleum Cement.

The Bureau of Construction and Repair, Navy Department, desired information on linoleum cement. It was found that the shellac cements, with alcohol as a thinner and with or without a finely powdered mineral filler, were more waterproof and held the linoleum more tenaciously to the concrete or steel than those cements made from dextrin or other water-soluble gums or from other resins cut in alcohol. Shellac cements with mineral filler adhered more tenaciously and did not become brittle on drying, as did shellac cut in alcohol without the filler. When water-soluble pastes were used it was recommended that a strip 1 foot on either side of the seams and edges should be cemented with a waterproof cement to keep out moisture and thus prevent the paste from molding. The Bureau of Construction and Repair have reported since the above recommendation that the failure of the water-soluble pastes was due to moisture in the cement floor, and when this was prevented by thorough drying they were justified in accepting the guarantee of the contractor, and have used this cheaper type of linoleum cement.

### Oakum.

A specification was also developed through cooperation with the textile division for oakum for the Emergency Fleet Corporation, which, as far as can be learned, is the first definite specification for this material.

### Separation of Benzol, Toluol, and Xylol.

As a result of the investigation made at Roberts coke ovens at Canal Dover, Ohio, a laboratory form of still head has been devised which gives remarkably sharp separation of benzol, toluol, and xylol. This still head will be described in a technologic paper. It furnishes a laboratory method for the separation of these compounds and may have an application in their industrial separation.

### Cement.

About 8,000 samples of cement were tested in the chemistry division. Full details of the Bureau's work on cement, including that of the chemistry division, are given in the report on cement, etc. (p. 495).

### Miscellaneous Tests.

For the Railroad Administration some 60 samples of boiler-feed water, boiler scale, and boiler compounds were analyzed to show, if possible, the merits of the Perolin treatment for boiler waters. This work is still in progress.

Many miscellaneous analyses and tests were made, covering soldering and welding fluxes, magnesia-asbestos preparations, furnace cements, aluminum sulphate for treating water, water from military camps, protective backing for mirrored surfaces, fire-extinguishing liquids, etc.

## PAINT, VARNISH, AND SOAP.

(Chemical analysis, testing, and exposure tests of paint and varnish; chemical analysis of and specifications for soap.)

### Paint Specifications.

*Interdepartmental Committee on Paint Specification Standardization.*—At the suggestion of the War Industries Board that the Department of Commerce attempt to prepare uniform standard specifications for paint materials, a conference of representatives of all the interested branches of the Government service was held at the Bureau on February 26, 1919. This conference recommended that an interdepartmental committee on paint-specification standardization be organized. This committee was organized and at present consists of one representative each from the War, Navy, Interior, Treasury, Post Office, Agriculture, and Commerce Departments, the

Panama Canal, Railroad Administration, and the Paint Manufacturers' Association. This committee has held a number of meetings and has prepared and recommended the specification for linseed oil, raw, refined, and boiled, which has been issued as Bureau Circular No. 82. The committee is considering specifications for other paint materials, and it is hoped that a number of such specifications will be issued within the next year.

*Miscellaneous Paint Specifications.*—A great number of miscellaneous paint materials specifications have been prepared. Mention may be made of two.

The War Industries Board requested specifications for paint to be used in housing projects for the Government and that an especial attempt be made to have these specifications cover the use of materials entirely of American origin. As a result of our cooperation with manufacturers and other experts, the War Industries Board paint committee recommended to the Housing Corporation specifications for a number of paints to be used on wooden houses.

In accordance with a request from the Forest Service, Department of Agriculture, specifications for white, cream, drab, cinnamon-brown, and green paints were furnished.

*Projectile Paints.*—In the latter part of the fiscal year ending June 30, 1918, and extending over to the present fiscal year, a large number of samples of very rapid drying paints for use on projectiles were tested at the request of War Department officials, and specifications were prepared and sent to the Edgewood Arsenal, Baltimore. Paints covered by this specification are very rapid-drying and were designed for use during periods of heavy production. The War Department, however, has specifications for projectile paint of a different nature than the above-mentioned, being much slower in drying, and the Bureau has not been able to learn which type of paint has been actually used by the War Department, although it would appear that the type contemplated by the Bureau's specification is far superior for periods of intense production than the material specified by the War Department.

### Protective Coatings for Ordnance Stores.

After the signing of the armistice the Ordnance Department asked for advice relative to the painting of guns, shells, and other equipment for storage. Experiments were carried out to determine the thickness of films on shells after brushing and spraying, and it was found that three coats of paint could be applied to shells without increasing the diameter to exceed the tolerances permitted. Recommendations were made as to the character of paint to be used for storing this type of equipment.

In addition to requests from the Army officers regarding methods of painting ordnance stores, a large number of requests came in regarding the use of oily coatings generally known as slushing oils. Formerly these materials were used for protecting bright parts of machinery for only short periods, and there is no information available as to the length of time that such coatings will afford protection. After examining a large number of samples of such materials, some mimeographed notes on protecting metal in storage were furnished to a large number of Army officers. They contain a general statement of the nature of such materials and proposed specifications for three types.

### Tests of Water Resistance of Enamels and Varnishes.

A very large number of samples of enamels and varnishes which were used on naval aircraft were tested for the Navy Department with a view to getting the most waterproof and durable coating to apply to wooden parts of airplanes. The net results of these tests seem to indicate than an enamel made of a vehicle of spar varnish and a pigment containing a considerable quantity of white lead is about the most satisfactory material available. The specifications were, however, at the Bureau's advice, changed so as to cover physical requirements and eliminating definite requirements as to composition of pigment.

### Fireproofing Fiber Board.

Some of the Army hospitals were made of a waterproofed wood-fiber board known as Insulite. This construction proved to be a very great fire hazard and at the request of the Construction Division of the Army investigations in cooperation with the Heat Division, with the object of lessening the fire risk, were made. It was found that a solution of water glass was the most successful treatment tried, and diminished the fire risk somewhat, but the danger from fire will always be very great with this type of construction. It was recommended that, as far as possible, the buildings constructed of this board be discarded and further use of this building material be discontinued, but that where the buildings could not be vacated all the interior walls be treated with a spray coat of a solution of water glass.

### Carbon-Tetrachloride Fire-Extinguishing Liquid.

At the request of the War Industries Board and the Quartermaster General, War Department, experiments were made to find a substitute for chloroform as a freezing-point depressant in carbon-tetrachloride fire-extinguishing liquids. It was found that gasoline and turpentine were both efficient, and the resulting mixtures were fire-extinguishing liquids. It is believed that the use of these depressants would have resulted in a very great saving in money to the War Department, but the signing of the armistice removed the necessity for the conservation of chloroform, which was the material previously specified as a freezing-point depressant, and it is doubtful whether gasoline and turpentine will be used for this purpose in normal times.

### Soap.

A great many samples of soap have been examined for all branches of the Government service. Additional specifications were prepared and a new edition of Circular No. 62, containing additional suggested specifications, was issued. In addition to the specifications given in the circular, others for shaving cream were prepared for the Purchase, Storage and Traffic Division of the War Department, and the Bureau is informed unofficially that these have been practically adopted. In connection with these soap specifications it may be mentioned that shaving cream and liquid soap are materials which the Bureau does not recommend. It is believed that the liquid soap is not as satisfactory as cake soap and the shaving cream is far more expensive than other types of shaving soap. There seems to be a demand for these articles; hence the specifications were prepared.

### Linseed Oil.

Linseed oil is the most important liquid used in the paint and varnish industry. It is, therefore, very important to not only have adequate determinations for purity, but to develop some tests for quality of oil of undoubted purity, since there is a great difference in the value of different lots of linseed oil of undoubted purity. It appears that the presence of foots is the most probable cause of inferiority in pure linseed oil. The test for foots was developed in this laboratory some years ago and has been incorporated in recent specifications.

The most important determination in ascertaining the purity of linseed oil is the iodine number. Unfortunately, there is quite a wide range in the iodine numbers of pure linseed oils from different parts of the world. It is, therefore, possible, with present methods, to skillfully adulterate linseed oil of high iodine number with other oils and pass the mixture as pure. The determination of the percentage of insoluble hexabromides has been frequently recommended as a much more reliable method of determining adulteration than the iodine number. Unfortunately, all the published methods for the determination of hexabromide have been faulty in that different analysts could not get concordant results with them. In the last few months some important work on this determination has been done in this laboratory and a tentative method prepared which is being tested in a number of other laboratories. It is believed that the defects of the older methods have been largely overcome and it is hoped that this method may prove of great value to the oil analyst.

### Miscellaneous.

Among minor problems handled may be mentioned determination of carbon in pigment, varnish for rifle and hand grenades, tests of proposed gasoline substitutes, and many other such problems.

## 6. ENGINEERING RESEARCH AND TESTING.

[Operative efficiency of mechanical appliances, accuracy of engineering instruments, conditions affecting their effective use, e. g., structure and design as related to durability and efficiency; methods of standardization and tests, standards of performance and fundamental researches on the scientific principles involved in speedometers, pressure gauges, water-current meters, anemometers, tachometers, gasoline and other motors, propellers, and other airplane parts and materials, etc.]

### MECHANICAL APPLIANCES.

(Investigation and calibration of special mechanical appliances; development of methods and apparatus for standardizing the performance of such appliances; investigation of operative efficiency of mechanical appliances, such as fire extinguishers, radiator traps, vacuum cleaners, etc.)

### Fire-Extinguisher Investigations and Tests.

An investigation of hand chemical fire extinguishers and similar apparatus, undertaken several years ago at the request of the Steamboat-Inspection Service, to determine the merits of devices of this character intended for use on vessels under its jurisdiction, was continued to include the investigation and test of apparatus offered for inclusion in its approved list during the past year.

A total of 78 fire extinguishers of various types were tested for the different Government departments.

The necessity for fire protection of gasoline-driven vehicles, airplanes, and similar risks where low temperatures may be encountered and other conditions of service preclude the use of older forms of apparatus depending on solutions of water, has resulted in the development of a 1-quart liquid-chemical extinguisher using an extinguishing agent consisting principally of carbon tetrachloride. Extinguishers of this type are peculiarly subject to deterioration after a short time in service. At the request of the Bureau of Construction and Repair, Navy Department, an investigation was made of extinguishers of this type to supply data to be used as a basis for establishing an approved list for the purchase of such devices. Results of tests conducted for this purpose, including tests after six months in service, on a number of samples of seven different makes of extinguishers showed the majority of the brands tested to be unsuited for the purpose intended.

To conserve the supply during the period of the war of certain chemicals used in fire-extinguishing fluids, a series of fire tests was made, in cooperation with the chemical division, to determine the effectiveness of substitutes proposed for this purpose.

A member of the section served on a committee of the War Department for the standardization of fire apparatus.

### Comparative Test of Roof Ventilators.

For the equipment of cantonments, hospitals, and other buildings it was necessary for the Army to purchase large numbers of roof ventilators. No reliable test data as to the efficiency of the various types and makes offered for sale were available. At the request of the Construction Division of the Army, a comparative test of some 33 different 18-inch ventilators was made in the Bureau's wind tunnel. The comparative efficiency of the different samples in exhausting air at different wind velocities under identical conditions for each ventilator was determined and a report submitted, in which the various makes of ventilators were listed, in the order of their merit, for the guidance of the purchasing officers.

### Thermostatic Valves for Vacuum Heating Systems.

The investigation of thermostatic radiator valves for vacuum heating systems for the Office of the Supervising Architect of the Treasury Department has been continued to include the new devices of this character submitted to that office in connection with buildings under its control. The efficient and economical operation of a vacuum heating system is principally dependent on the successful operation of these valves, one of which is connected to each radiator outlet. Tests are made under different working conditions to determine whether these devices are successful in keeping the radiator up to the temperature of the steam supplied, by the continuous removal of air and water, without permitting the waste resulting through the escape of uncondensed steam to the return line.

Performance specifications for these valves have been formulated and are being used by the Treasury and other Government departments in the purchase of equipment of this character.

### Miscellaneous Tests of Mechanical Appliances and Equipment.

Numerous miscellaneous tests of mechanical appliances were made of a more or less extended character, including a series of tests of relief disk and fusible plugs of high-pressure valves for use on hydrogen cylinders, and numerous tests of powder containers for the War Department, tests of reducing valves, steel tubing, flexible metallic hose, relief valves, pipe fittings, etc., for the various Government departments and for private firms.

## ENGINEERING INSTRUMENTS.

(Investigation and calibration of engineering instruments, testing of water-current meters, water meters, high and low pressure gauges, speedometers, anemometers, and tachometers; researches on problems affecting the precision of operation of such instruments, including standards of performance.)

### Water-Current Meter-Rating Station.

In the development of the water resources of the country in power development, irrigation, flood prevention, and similar projects an accurate knowledge of the quantity of water being discharged through rivers and other open channels is essential. These data are based on measurements of the velocity of the flowing water made with current meters. To insure the accuracy of these measurements, these instruments must be periodically calibrated by towing tests in still water.

Installations satisfactory for this purpose, involving the use of a body of still water and suitable means of propelling the meter through the water over a range of uniform velocities, together with instruments for making the necessary observations, are so costly as to be practically limited to Government stations or those at large universities. The inclosed rating station maintained for this purpose at the Bureau furnishes exceptional facilities for the calibration and study of these instruments.

During the past fiscal year a total of 184 current-meter ratings were made for engineers in Government and private service.

A series of tests was made of two experimental meters submitted to the Bureau to determine their suitability for the special purpose for which they were designed.

### Calibration of Engineering Instruments.

During the fiscal year calibrations were made of 201 pressure and vacuum test gauges, including gauges for the measurement of pressures up to 30,000 pounds per square inch, 12 tachometers, 10 anemometers, and a number of miscellaneous tests of instruments, including indicators, speedometers, etc.

### Theory of Measuring Instruments.

The work on this subject discussed in the last annual report has been continued. The errors commonly known as calibration errors, when they are repeated consistently on successive readings, are not seriously detrimental in the laboratory use of measuring instruments, as they can be corrected by simple calculation. Variant errors, on the contrary, are characterized by failure to repeat their values on repeated trials, and hence their correction requires special analysis and treatment. The research which was originally intended to lay down specific definition and formulation of the variant errors of measuring instruments has resulted, in addition, in the development of a method by which the accuracy of determinations made with indicating instruments under certain specified conditions of use and manipulation can be signally increased, oftentimes fiftyfold. In connection with this work it was shown that when the conditions surrounding the use of an instrument are subject to control in certain simple respects even an instrument of crude and inaccurate construction can be made to furnish results of surprisingly accurate character. The researches forming the experimental basis for this method have been published in one of the scientific periodicals.

The general principles developed during this investigation have also resulted in a new method of specifying the performance of a wide range of measuring instruments. Thus it was shown that an indicating instrument is analogous to a specimen of structural material under stress, in that the occasioning of a deflection, after cyclic operation has been set up, implies the storing up of a definite amount of mechanical or other energy in the instrument. The completeness with which the stored energy is restored when the deflection is again reduced to zero may be called the "resilience" of the instrument and affords a useful measure of the perfection of the instrument as regards the consistency or reproducibility of its determinations. This is a result of the fact that all causes which produce variability, or, as it may now be more exactly termed, variancy, of a sort which is inherent in the operation of an instrument itself, rather than in its environment, can be correlated with energy dissipation due to the imperfect "elasticity" or the energy-transformation inefficiency of an instrument. The relative magnitudes of this energy loss for instruments of different types designed for similar purposes afford a criterion of quality which is in large measure effective in establishing a definite basis for selection of an instrument for a given purpose.

These studies have been extended to determine the effect of vibration, or tapping, upon the indications of an instrument, and it was found possible to establish the general relation of the calibration obtained under these conditions to that obtained when the instrument is operated slowly and aperiodically without jarring. A general discussion of the subject of the variance of measuring instruments, with suggestions for its numerical specification and for its correction in laboratory practice, was presented before a scientific society by the Bureau's expert in this field.

The immediate application of these results is to instruments of the so-called indicating types, in which the momentary value of the quantity measured is shown (as a pressure gauge or a weighing scale), rather than to those of the integrating or totalizing type, in which the summation or total of the values registered up to the time of observation is recorded (as a watt-hour meter or a clock). These investigations have shown the necessity for exact definitions of a number of the terms entering into the specification of instrument performance, including accuracy, sensitiveness, passiveness, hysteresis, lag, resilience, variance, gross precision, and effective or useful precision. A publication is, therefore, being prepared in which all these terms will be clearly set forth and discriminated and a method for the definite performance rating of instruments will be outlined.

## AERONAUTIC INSTRUMENTS.

(Investigation, testing, and experimental development work on all types of aircraft instruments, including altitude-measuring instruments, rate-of-climb indicators, engine-speed and air-speed indicators, airplane-pressure gauges, gasoline-supply gauges, inclinometers, banking indicators, turn indicators, bomb sights, and oxygen-control apparatus; also mercurial barometers, weather and surveying aneroids and sphygmomanometers; development of methods of testing, improvement in design of such instruments, fundamental researches on the physical principles of such instruments, study of their operation in actual service, and determination of corrections required for aircraft-performance tests.)

### Fundamental Theoretical Work.

There are various instruments which have some physical problems in common. These have been solved once for all by general mathematical methods, so that the results can be applied to individual cases as they arise. Problems concerning the flow of fluids which may be met in the rate-of-climb indicator, in air-speed indicators, and in oxygen-control apparatus form one such group. Another is the determination of the combined effect of thermal expansion and change of elasticity with temperature on instruments constructed with springs and diaphragms. A third group deals with the theory of errors. The results of such investigations are to be found in Scientific Paper No. 331, A Relation Connecting the Derivatives of Physical Quantities, and in the technical information circulars referred to below.

### Development of Standard Testing Equipment.

Recommendations for standard testing outfits and procedure for testing altimeters have been furnished at the request of the French Government, the Canadian Government, the United States Navy, the Engineer Corps, and the Bureau of Aircraft Production of the United States Army. In the last instance the first barometers needed were designed and constructed by the Bureau; later orders were filled commercially on the basis of Bureau of Standards' specifications. The first equipment available for testing oxygen apparatus was also developed by the Bureau and adopted by the Army and the instrument manufacturers. In addition to such equipment, which was developed for use in production and inspection work, the Bureau's own standards, necessarily of a more refined degree of accuracy, were further improved during the year. For example, in the tachometer laboratory a standard test set was constructed in which a master tachometer of the liquid type, carefully studied for temperature errors and lag, is connected to a large motor-driven flywheel to insure steadiness of indications; and for checking it against the standard time signals of the Bureau an automatic electro-magnetic clutch was devised. To facilitate testing tachometers in quantity, a multiple-connection drive was made. A large sound-proof chamber was built for the continuous running of vibration tests with a minimum of disturbance to the other workers in a seriously overcrowded laboratory. A vacuum chamber with mercury-seal connections for the driving-shaft was constructed for testing certain tachometers under altitude conditions. Similar improvements were developed in all the other laboratories of the section. In addition, methods for testing rate-of-climb indicators and gyroscopic-turn indicators were originated during the year.

**Construction and Performance Specifications.**

On the occasion of a trip to Europe six years ago a comparison was made between the British, French, and German performance specifications for aneroid barometers and those issued by the Bureau. Soon after our country entered the war a critical study was made of the British specifications for standard airplane instruments which had been placed at the disposal of the aeronautic instruments section of the Bureau by the Royal Flying Corps. At the same time a survey was made of the manufacturing facilities of the country. Thus the Bureau was already prepared, when called upon by our aviation authorities, to give advice in regard to instrument production and to render expert assistance in preparing specifications. As a result all the instruments adopted as standard by the Army and Navy were based directly or indirectly on specifications originating in the Bureau. During the past year this work has been continued.

**Researches on the Errors of Instruments.**

Aside from the ordinary errors met in engineering instruments, such as incorrect calibration, parallax, looseness or friction in the mechanism, elastic hysteresis, and secular changes, those used on aircraft may be further influenced by the physical conditions peculiar to aviation, viz, (1) extreme drop of atmospheric pressure, (2) extreme change in temperature, (3) vibration, (4) acceleration or inclination. For example, a pressure gauge of the Bourdon-tube type suitable for the engine room may not be accurate when chilled much below the freezing point; and a tachometer of the air-viscosity type, perfectly suitable as an automobile speedometer, may show from 5 to 10 per cent drop in reading at a pressure corresponding to an altitude of 25,000 feet. Experiments to determine the characteristic errors of different types of construction for each of the various instruments have been continued and extended during the year. Such investigations are, perhaps, the most essential feature of the laboratory work of the section, and have been of especial importance during the war on account of the tendency for the errors to get larger whenever production is speeded up. The results provide a basis for performance specifications, for improvements in design or in production processes, and for estimating the corrections of instruments in use. In the case of altimeters, tachometers, and air-speed indicators the foregoing data have been supplemented by a statistical analysis of the results of the routine tests. Of especial interest during the past year may be mentioned a comparative study of the various physically different types of tachometers (chronometric, centrifugal, magnetic, electric, air-impulse, air-viscosity, and liquid types); a determination of complete corrections for the barographs employed in a flight which established a world's altitude record; and an experimental study of Venturi tubes. The latter comprised experiments in a water channel and in a so-called vacuum wind tunnel, for the observation of effects due to the density, viscosity, and compressibility of the medium. It will serve as a starting point later for the computation of altitude corrections for air-speed indicators.

**Flight Tests on Airplane Instruments.**

Taking with him in an airplane instruments previously studied in the laboratory, the expert physicist is able to observe and explain peculiarities in their behavior which might pass unnoticed by the aviator, yet prove serious later. Such a flight was made in 1913 before any instruments distinctively designed for airplane use were yet on the market, and they have been continued at intervals during the war in cooperation with the aviation authorities. Among those made during the summer and fall of 1918 was a seaplane flight on a dark night for the demonstration of a projection type of night-altitude indicator; also a trip across the Channel from England to France, at which time a comparison was made between the British and American compass; a performance test of an airplane 3 miles up over the suburbs of Paris; a series of high-altitude flights for the study of oxygen apparatus; flights for the testing of rate-of-climb indicators; and flights for the testing of gyroscopic and other inclinometers.

### Instrument Collection.

Extensive additions have recently been made to the collection of aircraft instruments, including a barograph of exceptional design by De Giglio, of Turin; a large French compass with unique mechanical features for use on dirigibles; and a combination German instrument containing fore-and-aft inclinometer, banking indicator, and gyroscopic-turn indicator. This collection has been of value for instruction, investigation, and instrument production, and undoubtedly is now one of the most complete in the world.

### Salvage Methods.

A study has been made of practical methods for repairing defective or damaged instruments, with particular reference to expedients for readjusting the mechanism so as to give a correct calibration, a more uniform scale, or a satisfactory degree of temperature compensation. Such work, especially on recording instruments, has at times been done at the Bureau, and the information has proved of value to American manufacturers and to our salvage officers and mechanics at flying fields here and in France.

### Study of European Instruments and Methods of Testing.

With the authority of the Secretary of War and Secretary of the Navy, a representative of the Bureau made a visit to the establishments of the American forces abroad, leaving in August, 1918, and including some of the principal airdromes, factories, and laboratories of the allied Governments in England, France, and Italy. This trip afforded an exchange of the latest technical information and provided first-hand knowledge of conditions attending the use of aeronautic instruments in military and naval operations. The reports of the Bureau's instrument investigations proved to be of interest at all points visited, and some of them were immediately duplicated or translated for confidential use. In return, valuable information and samples of instruments and materials were made available to the Bureau, and a number of urgent experimental problems were proposed for the Bureau to take up. As an aid in the study of the technique of instrument testing, eight typical American instruments (altimeter, air-speed indicator, compass, thermometer, two pressure gauges, and two tachometers) which had previously been tested at the Bureau were taken over and submitted for test at the Royal Aircraft Establishment in England, and elsewhere. The success of the trip was largely due to the cordial cooperation of Maj. George M. Brett, chief of the airplane instrument and testing division of the American Air Service in France.

### Instrument Instruction for Aviation Officers.

At the request of the Navy Department a school of aeronautic instruments for navigation officers was conducted by the section in the fall of 1918. This was an intensive course of three weeks' lecture and laboratory work covering the theory and testing of the various instruments and concluding with a written examination. A somewhat similar, though shorter, course had been given the previous year. Information and photographic material has also been furnished for the use of the Army in instruction courses for military aviators.

### Experimental Development Work.

1. Drawings were made for a recording air-speed indicator with metallic diaphragms.

2. The problem of ground-speed measurement by dynamical or other methods not depending on the visibility of the ground has been investigated and a model illustrating the principle of one such type has been constructed. Such instruments require stabilization.

3. Detail drawings of a gyro stabilizer for instruments had been prepared at the time of the armistice and a working model of about one-fourth size constructed. A bomb sight and double-pivot compass to go on the stabilizer formed a part of the design. The continuance of this work would be of value for navigation purposes. The double-pivot compass appears to be the only suggestion thus far put forward for theoretically eliminating the "northerly turning error."

4. Inclinometers of the liquid type have been constructed for the National Advisory Committee for Aeronautics and two new types of banking indicator developed by the Bureau.

5. By engraving special dials and redesigning the mechanisms certain altimeters submitted by the Army, Navy, and National Advisory Committee for Aeronautics have been converted into instruments more suited for performance tests on aircraft.

6. The conversion of low-altitude into high-altitude barographs by the Bureau's method has been continued at the request of the Army.

7. A study has been made of the possibilities of different principles for recording airplane vibrations, including the piezoelectric effect, and several trial vibrometers constructed. In this connection a new type of vibrating stand has been developed which has greater adjustability than previous forms, and which does not subject the driving motor itself to the vibrations; also a model has been constructed illustrating the theory of so designing the movable parts of instrument mechanism as to balance them against the effect of sudden angular accelerations, such as chiefly compose the instrument-board vibrations of an airplane.

8. A new feature in oxygen-control instruments, which would avoid the main source of temperature error, was developed.

9. A preliminary model of an improved centrifugal tachometer has been constructed and found promising in several particulars.

10. A start has been made on the experimental work in connection with the construction of a large open-scale altimeter at the request

of the National Advisory Committee for Aeronautics. Such an instrument, though not a commercial proposition, is greatly needed in aircraft-performance tests. In connection with the work of the altimeter laboratory, a study has been made of the possibility of combining thermometric and pressure elements into a single mechanism. One such combination would afford a true altitude meter, whereas the existing altimeters assume a fixed temperature for the atmosphere and require the computation of large corrections. Another combination mechanism would give a direct-reading density meter. Three methods also have been proposed for avoiding the evil of elastic fatigue in altimeters. One consists in providing an auxiliary instrument with a very open scale reading only to 1,000 feet, above which point it is automatically shut off from the atmosphere, and thus protected from the strain which causes fatigue. A second consists in making the steel mainspring of the altimeter so much stiffer than the diaphragms that the latter, however poor the material may be, can only contribute a small proportion of the observed result; this method is made possible as a result of experiments which have shown that the steel springs of good commerical aneroids have only an insignificant amount of fatigue in comparison with the diaphragms. A third method is the obvious, but less immediate, one of developing eventually better materials or designs for the diaphragms. This is described under (14) below.

11. A rate-of-climb indicator has been developed, using thin metallic diaphragms in place of the usual liquid manometer. The latter has the disadvantage that the readings are seriously affected by inclination and acceleration. A comparative test in airplane flight was in favor of the Bureau's instrument, except for the time lag, which should be further investigated.

12. In addition to the electric-spark-recording process, other ink substitutes have been studied and a successful radium method developed. In this connection plans have been made also for the use of the moving-picture camera for securing a record of the instrument readings during an airplane-performance test.

13. Altimeter chains have been studied by a special life-testing device, and the superiority of gold chains thus far indicated.

14. Diaphragms have been spun in the instrument-development shop of the section and given a mechanical aging treatment. This process has been found more effective than heat treatment in reducing the elastic feature of unseasoned material. The elastic properties of a large number of diaphragms, made from alloys selected in consultation with the metallurgy division, have been measured in the hope of producing a material or a design superior to those in commercial use. This work has been done at the request of the National Advisory Committee for Aeronautics, and is to be continued.

**Testing of Aeronautic Instruments.**

During the past 12 months 578 tests have been made on instruments submitted from outside. The value of these tests on the basis of the Bureau's fee schedule would aggregate about $10,000. They were distributed as follows: 148 altimeters, 63 barographs, 50 statoscopes, 6 mercurial barometers, 74 air-speed indicators, 59 sets of oxygen apparatus, 134 tachometers, 18 pressure gauges, and 26 special instruments or appliances. The latter comprised 2 gasoline-depth gauges, 2 aerographs, 8 reducing valves, 5 aneroid stacks, 2 unit sights, 2 inclinometers, 1 electromagnetic rate-of-climb indicator, 1 night altitude indicator, 2 bomb sight speed regulators, and 1 gyroscopic-turn indicator. Practically all the tests included endurance runs or some other feature making them more complete than the factory-inspection tests. Many of them were in the nature of short investigations to determine the suitability of new types of instruments for production. In addition, 95 thermometers and 9 compasses were tested by the heat division and the electrical division of the Bureau. The list does not include tests made on instruments developed by the Bureau, nor upon instruments submitted solely for the collection.

### Technical Information Circulars.

The series of aeronautic-instruments circulars for confidential distribution begun the previous year has been continued. These documents are duplicated for temporary use and serve to make the results of the Bureau's investigations immediately available to authorized persons. The following were issued during the year: Spinning-Top Inclinometers; Historical Notes on Aneroid Barometers; Two Aneroids Tested in England, France, Germany, and the United States; Methods for Testing Aneroid Barometers; Testing Methods for Airplane Tachometers; Air-Speed Indicators; Statoscopes and Climbing Indicators; List of American Instrument Manufacturers; High-Altitude Barographs; Report on a Group of British Instruments; Report on a Group of Danish Instruments; Methods for Testing Air-Speed Indicators; Gasoline-Level Gauges; Airplane Pressure Gauges; Instruments Tested January 1 to June 30, 1918; Inclinometers; Airplane Tachometers; The Theory of Dimensions with Applications to Instrument Work; A Theory of Irreversible Time Effects, with Applications to Instrument Work; Mechanical Design of Aneroid Barometers; Temperature Compensation of Aneroid Barometers; A Night Altitude Indicator; A Proposed Plan for Bomb Sighting; Airplane Thermometers (contributed by the heat division of the Bureau); Report on a Group of American Instruments Tested Abroad. Owing to the limitations of the Bureau's photographic service, it has not been found possible to keep up with the demand for this material, even though it has not yet been publicly announced as available.

### Correspondence and Conferences.

Much information and advice has also been given out in reply to official correspondence and in response to verbal requests. A considerable part of this consisted in the examination of inventions in connection with aeronautic instruments and other appliances submitted by the General Staff of the Army and by the National Advisory Committee for Aeronautics. Members of the section individually conversant with some particular branch of physics, as elasticity, capillarity, viscosity, high-pressure measurements, or the theory of errors, have frequently been called upon for conferences with visitors or for cooperation with some other section of the Bureau. During the summer of 1918 the section was visited practically every day by production officials of the Army or Navy to follow the results of investigations or discuss specifications, with occasional visits also from foreign delegations. And in accordance with the Bureau's policy of cooperation with other organizations the chief of the section has served, by request, on the subcommittee for lubrication of the research committee of the American Society of Mechanical Engineers; on the airplane-instruments committee of the International Aircraft Standards Board; and on the aerodynamics committee of the National Advisory Committee for Aeronautics.

### Cooperation with American Manufacturers.

The Bureau has been of assistance in building up an American instrument industry not only by carrying out fundamental researches which no single manufacturer could undertake but also by continuously helping manufacturers to improve their product in matters of detail. This has been accomplished by frequent informal conferences at the Bureau and in the factories, and at times also by telegraphic reports. At one time a certain manufacturer complained that the Bureau's performance specifications for barographs, on which his contract was based, were too strict in their requirement for temperature compensation and wished to have instruments accepted which were four or five times over the limit. Before reconsidering any tolerances the Bureau's expert was sent to the factory with scientific suggestions for diminishing the error in question. Less than two months later this manufacturer was successfully producing instruments averaging only one-half the temperature error permitted by the specifications. This experience is merely typical of many other instances.

### Cooperation with American Physical Society.

At the request of the society this section contributed several papers by title at the spring meeting on war problems, three of which were presented in full, dealing, respectively, with general investigations of air-speed indicators, tachometers, and altitude instruments. A large exhibit of instruments and testing appliances was shown at the same time as a part of the society's exhibition. This included tachometers, gyroscopic instruments, a rate-of-climb indicator, and other devices in actual operation.

### Cooperation with National Advisory Committee for Aeronautics.

This section has cooperated continuously with the Advisory Committee, avoiding duplication of Government facilities by serving in effect as the instrument laboratory of the committee. A considerable group of aeronautic instruments, together with graphical charts, also a whirling table of banking indicators, a vibration stand, and a chain-testing outfit, all kept in motion by electrical connections, were contributed to the exhibit of the Advisory Committee at the Manufacturers' Aircraft Exposition in New York.

### Future Development of Aeronautic Instruments Work.

The instruments of an airplane or dirigible are its sense organs. It can fly without them, but only blindly. When one considers the ever present danger of a crash in the fog, together with the high cost of the large aircraft now coming into use, any reasonable expenditure for improving the reliability of the instruments justifies itself at once, even without taking into account the value of human life. A further need for instrument investigation comes from the fact that those types of instruments which are adapted for measuring aircraft performance underlie the whole future development of aeronautical engineering, since this all goes back in the end to questions of measurement. For these two reasons alone no financial investment in aeronautics of any moderate magnitude could be more productive than one devoted to the advancement of instrument work.

## AERODYNAMICS.

(Fundamental data of aerodynamic physics as applied to the study of the resistance of air to the motion of bodies, including the magnitude, direction, and point of application of the resultant force, and its relation to the relative speed; study of the aerodynamical properties of airplane-wing models, stability of model airplanes, efficiency of propellers and wind motors, characteristics of air bombs, and the testing of airplane equipment and other apparatus functioning in an air stream.)

### Wind-Tunnel Investigations.

The Bureau now has in operation two wind tunnels of the open type, the larger of which is well adapted for the testing of model airplanes and wing sections, while the other, and smaller one, is used in the testing of airplane equipment in which the attainment of high air speeds is necessary.

The 54-inch octagonal tunnel is housed in a room 79 feet long, 29 feet wide, and 18 feet high, and is equipped with two weighing balances. One balance is of heavy construction and is designed for the measurement of lift and drag forces on heavy models, such as air bombs and engine radiator sections. The second balance is much more sensitive, and is used primarily in the determination of the characteristics of aerofoils and airplane models. From these models test predictions may be made of the behavior in flight of the full-scale machine. In this tunnel air speeds ranging from 5 to 90 miles per hour are obtainable.

To keep pace with modern aircraft developments, the Bureau began in October, 1918, the construction of a high-speed wind tunnel. This tunnel, which was completed and in operation in April, 1919, is of the Venturi type, 36 inches in diameter at the throat or working portion, and is constructed entirely of wood, the tunnel proper being built up of cypress-wood segments. The tunnel was designed for a maximum wind speed of 150 miles per hour at an expenditure of about 100 electrical horsepower. In subsequent tests, however, air speeds of 180 miles per hour were obtained with an expenditure of 120 electrical horsepower. The wind stream is maintained by a tractor propeller, 7 feet in diameter, connected directly to a 125-horsepower direct-current motor. The tunnel is housed in a room 106 feet long, 27 feet wide, and 12 feet high.

Besides work of a distinctly military nature, such as studies of the characteristics of aircraft bombs, time constants of arming vanes, methods of driving aircraft reconnoissance cameras, and calibration of variable-pitch propellers for wireless sets, tests have been made on a number of monoplane, biplane, and triplane models and on a large number of wing sections. These latter included tests on a series of ribbed aerofoils, a series of German wing sections, and a series of aerofoils in connection with the design of an automatic variable camber wing.

Cooperation has been afforded aircraft designers and manufacturers in the calibration of various types of air-speed indicators and in the determination of the characteristics of aerofoils and airplane models.

### PHYSICAL OCEANOGRAPHIC INSTRUMENTS.

(Assistance in design and construction of physical oceanographic instruments.)

In cooperation with the scientific work of the International Board on Ice Observation, the facilities of the Bureau have been extended for the design and construction of new oceanographic instruments. A convenient, accurate instrument to measure the saline content of sea water has been designed and constructed and successfully used on shipboard. Any instrument to be used at sea must be simple, convenient, easily operated, and rapid.

An investigation is now in progress to determine the relative accuracies of the several methods of measuring sea-water salinity. Samples of sea water have been forwarded to the Bureau and measurements of these have been made by the chemical, electrical, and density methods, and the results obtained are to be compared with a method of hydrostatic weighing. This work is being done in cooperation with the Bureau of Fisheries.

## 7. STRUCTURAL, MISCELLANEOUS, AND ENGINEERING MATERIALS.

[Investigation of properties, use, fabrication, and design of structural, miscellaneous, and engineering materials; development of specifications covering the use of such materials; improvement of processes of manufacture; improving present and developing new methods of testing; development of testing apparatus.]

### METALS.

(Development of airplane design, including structures and appurtenances and discovery of suitable materials for construction purposes, especially metal construction; investigation of processes for kiln-drying of timber; investigation by means of the strain-gauge of structures under load; welding research for ship construction; calibration of testing machines and extensometers; standardization of hardness testing with various machines; determination of the physical properties of metals, woods, molded materials, and rope.)

### Variable-Camber Airplane Wing.

One of the most important investigations carried on by this section during the past year is that of the variable-camber wing, so named because of its change from stream line to lifting shape with a change in flying speeds. This work was carried on in cooperation with the National Advisory Committee for Aeronautics, who suggested the problem.

With the present form of airplane, it is found that the landing speed is about one-half the maximum attained in flight. If the speed in flight is great, which is particularly the case for military work, the landing speed becomes almost prohibitive.

This wing has been designed so as to assume the cambered or lifting form when the airplane is traveling at low speeds. This change in form is due to the pressure of the air upon the lower surface of the wing. The pressure is caused by the forward motion of the machine with the planes tipped from the horizontal so that their leading edges are about 6 inches above their trailing edges.

The shape of the cambered wings is such that their lifting capacity is great, and their minimum speed low. As the speed increases after a flight is begun, the wings are gradually changed so that the leading edge is brought nearly at the same level as the trailing edge. The pressure of the air upon the variable-camber wing then becomes equal on the upper and lower surfaces, and the wing assumes a stream-line shape which offers only about one-quarter the air resistance of the cambered wing. Any decrease in resistance causes a corresponding increase in the speed of the airplane if the engine thrust is constant, which is practically the case.

In order to determine the behavior of the variable-camber wings when combined with the usual form of wing in both biplane and triplane combinations, models were tested in the wind tunnel at this Bureau. The results of an extended series of experiments showed that their behavior was entirely satisfactory.

This problem has been carried as far as possible in the laboratory, and shows promise of operating satisfactorily in actual use. The work has progressed to the stage where it should be tried in actual airplane construction, first to be sandloaded to prove that its behavior under load is satisfactory, and that the structure possesses the required strength. A variable-camber airplane should then be used to demonstrate its value in actual flight. If expectations are fulfilled, there is no doubt it will prove a great stride forward in airplane progress.

### Test of 150-Ton Floating Crane for the Navy.

At the request of the Bureau of Yards and Docks, Navy Department, strain-gauge measurements were taken on some of the important members of a 150-ton (336,000 pounds) revolving floating crane built for use in the navy yard at Norfolk, Va.

This test was made to determine the distribution of stress among the various members of the crane while under load and to obtain a more complete knowledge of the actual amount of stresses in some of the members of this statically indeterminate structure.

This crane represents the most advanced type of revolving floating crane of large capacity. The jib is a tapering Pratt truss, hinged to the superstructure in the lower chord and connected to the luffing screws at the upper chord by suitable links. The length of the links and the location of the luffing screws are such that a nearly direct pull is exerted on the upper chord of the jib for all positions. The superstructure, exclusive of the jib, consists of two subdivided triangular trusses rigidly connected by cross bracing. The entire revolving load is transmitted by the triangular trusses to the pontoon through a pintle, the pintle being an inverted pyramidal shaped member built up on four posts, which transmits its load at the apex to a thrust bearing on the deck of the pontoon. The pintle is supported laterally on a tower consisting of six legs arranged in the form of a hexagon, the legs of the tower being carried through the deck to the framing of the pontoon. The tower is framed into the hull in such a manner as to make the pontoon act as a large girder in resisting the forces induced by a crane load. The pintle rotating within the tower makes it possible to revolve the superstructure with the live load to any position.

Readings were taken at various points of the deck to determine the magnitude and, if possible, the position of the maximum stress in the upper-deck plate; on the tower members, to determine whether the tower acted as a unit; around the manhole in the tower legs, to find the effect of such an opening; on the pintle, to determine the magnitude of the stress in these members; and on various members of the superstructure, to determine the manner in which the loads were carried down to the pintle.

Gauge lines were placed on two opposite sides of every member tested, and, where possible, on all four sides. Gauge lines were laid out on the deck of the pontoon for the purpose of determining the amount of stress developed in the plates of the pontoon deck and to check the computed locations of the maximum bending moments.

Strain-gauge readings were taken with a 10-inch Berry strain gauge, it being possible to read the change of length between the points of the instruments directly to the nearest 0.0002 inch, and by estimation to 0.00002 inch.

The material used for loading the crane consisted chiefly of armor plate and scrap iron of known weight. The loading was so arranged that each member on which measurements were taken was subjected to the maximum possible range of stress.

The strain-gauge work done on this structure showed that all stresses on the various members were within safe limits.

### Tests of Motor-Truck Wheels.

In designing class B military truck it, was found desirable to develop a metal wheel having the good qualities of all the wheels on the market. As there was not sufficient time to make service tests, this section conducted radial-compression and side-thrust tests upon cast steel, pressed steel, wrought iron, and wood wheels made by various manufacturers. From the data obtained from these tests a cast-steel wheel known as the "composite" wheel was designed. This type of wheel proved satisfactory in test and was, therefore, adopted for use on the class B truck.

Twenty-one wheels were tested. The deformations of the wheels under the radial-compression tests were recorded for four points on the rim spaced 90° apart. Similar data were obtained from the side-thrust or skid tests.

From these test data, the limit of proportionality, ultimate strength, rate of deformation, and elastic resilience were found for each wheel.

Strain-gauge measurements were made upon one cast-steel wheel to determine the stress distribution.

A stress analysis of this kind should prove valuable in the design of wheels, and the many inquiries from wheel manufacturers for these data show their interest in such work.

### Tests of Electric Welds.

The urgent need for ships to transport our men and material to Europe during the recent war with Germany made it necessary to adopt every means of securing maximum output from the shipyards of this country. The "fabricated" ship, constructed from plate material on which all cutting and drilling had been completed at remote mills before shipment to the yard, saved time at the shipyard under the conditions existing during the war.

Another radical suggestion, which was never used to the extent which its merits warranted, was the electric welding of the frames and plates of the hull instead of riveting. Autogenous or fusion welding has been in use for many years. Most of this work has been done by the use of the gas torch, to which oxygen and acetylene are supplied. The weld is formed by fusing together the adjoining edges of the pieces of metal. Material is sometimes added at the same time from a metal rod.

In the electric-arc welding process, the fusion of the metal is effected by an electric arc formed between a metal rod (or electrode) and the pieces to be joined. Metal from the rod is deposited in the weld.

Due to the prohibitive cost of the gases required for oxyacetylene welding, its use upon ship hulls was greatly restricted and the possibility of using electric welding to replace riveting was carefully considered.

The Welding Research Committee of the Emergency Fleet Corporation was formed to study the matter carefully and conduct any needed investigations. This Bureau had representatives on the committee and performed much of the laboratory work for determining the properties of the welds, particularly the strength.

In order to obtain definite information upon welds which were being made commercially, a large number of pieces of one-half inch steel plate were welded at different shops, using all available types of apparatus. These were known as the Wirt–Jones tests and attracted a great deal of attention from engineers and shipbuilders.

The welding data included a mark by which the operator could be identified, the position in which the weld was made, the type of weld, and the rate of welding. The type of electrode used with the diameter and manufacturer, as well as the arc and open-circuit voltage and the amperage, were recorded for each test weld.

These data were obtained in the shops where the welds were made. The specimens were machined there and elsewhere.

The physical tests were all made at the Bureau of Standards and consisted of tensile, torsional, fatigue, and cold-bending tests.

It was found that all of these, except the fatigue tests, which gave erratic results, were consistent. A specimen showing high strength in the tensile test showed high strength in the torsional also. Those specimens showing relatively high ductility in the tensile tests showed equally well in the cold-bend tests. The fatigue tests were made in three Upton-Lewis machines and by three different engineers. Unfortunately, the results do not appear as consistent as could be wished. Many fatigue experiments should be conducted if reliable data are to be obtained upon this important property of welds. It is believed by many engineers that the failure of welds in service is usually by fatigue, and that this property of welds is relatively more important than the fatigue resistance of the material in which the weld is made.

In an extension of the experimental work to determine the fatigue resistance of welded joints such as would be actually used in ship construction large specimens were made from plates one-half inch thick, 8 inches wide, and 40 inches long.

A fatigue machine driven by a 15-horsepower electric motor was designed and built to subject these specimens to repeated bending stresses with provision not only for recording the number of cycles of stress required to cause failure, but also for making an auto-graphic record of the stress produced in the welded material for each application of load.

The total number of specimens in this series was over 200, and the testing work required most of the time of two engineers for nearly a year.

In addition to the Wirt-Jones tests, this Bureau was at one time making progress reports to the welding committee on 14 investigations planned to give information upon some of the many problems constantly arising in connection with welding work. The number of specimens involved in these investigations varied from 5 to 42.

Due to the satisfactory results obtained from these tests, it was decided that the electric-arc welding process was suitable for ship construction, and the committee formally recommended to the Emergency Fleet Corporation that a merchant ship be designed to utilize welding wherever it could be employed to advantage, and that the ship be completed as soon as possible.

The signing of the armistice took place before much progress was made, but some commercial shipyards are now energetically preparing to construct ships in which nearly all the frames and plates for the hull are welded into place.

It is estimated that the cost of welding will approximately equal the cost of riveting plates and frames after they have been "laid off" and the rivet holes punched. For welding, however, all this preliminary work is unnecessary, and the plates and angles do not need to be as accurately cut to dimensions. The saving, if welding is used, is therefore very large and it is chiefly a saving in labor cost, which under present conditions constitutes a large portion of the total cost.

One result of these extensive investigations was the important conclusion that the best physical properties were obtained from those specimens welded with the highest current density in the electrode. Apparently, under this condition, thorough fusion occurred in the weld.

The importance of this discovery, which is generally accepted at present, is very great. The fact that little properly conducted investigational work has been done upon welding processes, and the many possible lines for improvement, leads to the conclusion that such work offers great possibilities if properly carried out.

The American Welding Society, an outgrowth of the welding committee, has been formed to encourage welding-research work by coordinating the efforts of industrial, educational, and governmental laboratories. This Bureau is assisting the work of this society in so far as possible.

### Tensiometer.

It is a well-known fact that it is very desirable to know the load that is placed upon the wires and cables of airplanes.

Heretofore no instrument has been available for measuring these stresses with sufficient accuracy. With this purpose in mind an instrument was designed by one of the members of the Bureau's staff and constructed in the Bureau shop. It consists chiefly of two supports at a fixed distance apart and a moving plunger located midway between them, by means of which the wire may be deflected a definite amount of 0.1 inch. The load on the wire is measured by an Ames dial, which measures the compression of a calibrated spring against which the plunger operates.

This instrument, which gives accurate readings on wires of small diameters, requires the use of calibration curves when heavy wire, cable, or stream-line sections are used. Two sizes of this instrument have been supplied at the instance of the Bureau of Construction and Repair, Navy Department, the smaller one being made for wires from 0.05 to 0.25 inch in diameter, and the large one for wires and cables from one-fourth to three-eighths of an inch in diameter. These two sizes of tensiometer were calibrated on 10 sizes of cables ranging from one thirty-second to three-eighths of an inch in diameter; on four sizes of hard-drawn wire and on four sizes of stream-line wire, and were found to give very satisfactory results.

The instrument is sufficiently accurate, being capable of indicating the actual load within 1 per cent of the actual load on the wire, if it is under a load of more than 1,000 pounds. It is simple in construction as well as quickly and easily operated.

Over a hundred of these instruments have been built and are being used by the Navy Department.

### Investigation of Wire Rope.

The results of an investigation on 275 wire ropes have been published in Technologic Paper No. 121. The ropes ranged in diameter from one-fourth to 3½ inches. Five important classes were tested: (1) Very flexible rope of 6 strands, 42 wires each, used for boat tillers and elevator hand lines; (2) ropes for guys of derricks, stacks, and haulage purposes having 6 strands, 7 wires each; (3) (4) transmission rope of plow and crucible cast steel having 6 strands, 19 wires each; (5) extra-flexible plow-steel rope of 8 strands, 19 wires each. The laws of construction and behaviors of the specimens have been reduced to empirical equations. The results of the tests are compared with the strengths called for in well-known specifications.

A further investigation has been carried out to determine the relative strengths of hoisting and transmission wire rope when used in connection with sheaves, as in the case of derricks and cranes. This investigation was made possible through the aid of a large manufacturing corporation supplying the necessary materials. The ropes varied from five-eighths to 1¼ inches in diameter and were tested when bent over sheaves of diameters 10, 14, and 18 inches. An abstract of the results was published in the Engineering and Mining Journal, April 26, 1919. It was shown that the strength on 18-inch sheaves varied from 96 per cent of the strength in direct tension for five-eighths-inch ropes to 87 per cent for the 1¼-inch ropes. The corresponding values for 14-inch sheaves were 95 and 82 per cent, and on 10-inch sheaves 84 and 77 per cent. The mean departures from this range were about 1 per cent. The above values should be reduced about 10 per cent when the strengths are expressed in terms of the aggregate strengths of the wires in a specimen.

The cables generally fractured at the point of tangency with sheaves. Cracks developed in several sheaves, showing that there were opportunities for improvements in design, but as a whole the strength of the sheave system was limited by the individual strengths of the wire rope, which as a function of the diameters was expressed by the formula $S=83{,}000\ d^2$.

### Oxyacetylene.

A carefully planned series of tests intended to demonstrate the economy and efficiency of oxyacetylene welding and cutting apparatus is being made. Apparatus from most of the leading manufacturers in this line has been received for test.

The tests are planned to show the conditions under which backfiring occurs, the characteristics of regulators under varying tank pressures, the economy of the apparatus in welding and cutting operations on material of various thickness, and in some measure the durability and the ease with which repairs can be made in service.

### Machetes.

A number of machetes, representative of material intended for purchase by the Panama Canal, were submitted for test to determine their suitability for use in cutting and clearing away brush and undergrowth of the Panama Canal district.

These machetes were subjected to a series of mechanical tests, such as Brinell hardness and cold bend, to determine the variations in properties which exist in the commercial product; that is, the hardness along and across the blade and its comparative toughness as indicated by bending. Chemical analysis and micrographic examinations were also made. These tests gave comparisons between various blades of one manufacture, indicating the constancy of his product as well as the difference between blades of different manufacturers.

While certain of the blades submitted proved unsatisfactory, in that they were brittle, most of the others passed all tests and apparently are satisfactory for the work intended, with the exception possibly of the Brinell-hardness number. None of the blades reached the desired hardness number. There was also some variation in carbon content, but the effects of this latter was generally made up by improved heat treatment.

Such tests might well be applied to a large number of cutting instruments.

### Brinell Hardness Table.

A Brinell-hardness numeral table, correct generally to the second decimal place, has been compiled and lithographed, which gives the Brinell-hardness numeral for each hundredth of a millimeter of diameter of indentation from 2 to 6.94 millimeters and for pressures of 500 and 3,000 kilograms.

Copies of this table will be sent gratis upon application.

### Piston Rods.

A number of tests were made on 8-inch recoil piston rods for 12-inch Barbette carriages at the instance of the Ordnance Department of the Army.

The rods were submitted for a tensile-proof load of twice the working load for the purpose of insuring the quality of the material entering into the forging. All of the rods which were tested in this manner proved entirely satisfactory.

### Nonscatterable Glass.

This protective glass, suitable for aviators' goggles and airplane wind shields, consists of a sheet of celluloid "welded" to one side of the glass, the intention being to place the celluloid on the side toward the person to be protected.

An interesting series of tests—that is, firing, to determine the effect of small-arm projectiles; cross bend, loading as a simple beam to determine its strength; and impact, to find the effect produced by the striking of a pendulum weight—were made on this glass to determine its value as a protective screen, and to note the effect the celluloid coating has on the strength of the glass.

In the firing tests it was found that the dangerous scattering of large pieces of glass was entirely prevented. The celluloid coating was easily scratched or marred. In the impact tests the plain glass was broken into many small pieces, while the treated samples cracked, but the pieces were held together by the celluloid. In the cross-bend tests the treated glass of a given kind and thickness was about 15 per cent weaker than the plain glass when the celluloid-coated side was in compression, and about 40 per cent stronger when the celluloid was in tension.

### Metal Airplane Construction.

No experimental work has been done during the past year upon the use of metal to replace wood in airplane construction, such as was carried on the previous year by this Bureau in cooperation with the Empire Art Metal Co. and the Airplane Engineering Division of the Bureau of Aircraft Production. Immediate interest in the subject decreased upon the signing of the armistice, but the future of metal construction appears promising, especially as the need for a fire-resisting airplane becomes more generally understood.

To avoid the difficulty which has been found in designing sheet-metal parts so as to secure sufficient compressive strength—as, for example, in the flange of a beam or spar—one engineer has devoted much time and study to the use of steel tubes. A single metal tube has much less strength for its weight than a beam designed to concentrate most of the material in the flanges which are subjected to the higher stresses.

The tubular design uses several small cold-drawn steel tubes for the flanges which are connected by diagonal latticing of tubes of smaller diameter. The design is very flexible in that the number of tubes used may be varied in the length of a single beam to meet the strength requirements. It is also possible to join tubes by inserting a snugly fitting tube of smaller diameter into another for a distance which will give satisfactory strength. Methods of fastening the two tubes together readily present themselves.

It is believed that encouragement and assistance given to metal construction by this Bureau is now about to result in material improvements in that field which will come into general use.

### Semisteel Shells.

At the request of the Ordnance Department of the Army, a number of 155-millimeter shells of semisteel have been subjected to a thorough examination as to mechanical, chemical, and metallurgical properties. In order to determine the probable stresses set up in shells that showed excessive expansion after firing, tests were made to determine the true elastic limit; that is, that stress at which permanent deformation is first produced. Further, a study was made of the variation in the chemical and mechanical properties throughout the length of the shell. It was found that the strength of the material, its hardness, and the percentage of combined carbon decreased consistently from the thin section at the nose of the shell to the heavy fuse sections. This agrees with what might be expected from such a material as semisteel, a modified cast iron.

The entire series of tests on semisteel shells also indicate that at present there is considerable variation in the mechanical properties and chemical composition of the so-called semisteel.

### Bronze.

Over 300 samples of bronze have been submitted by Division VIII for tests. Among the different varieties were the following:

Cast, both heat-treated and not heat-treated, phosphor, Government, nickel, and welded bronze.

Tensile tests were made on these specimens in order to determine their proportional limit, ultimate strength, elongation, reduction of area, and modulus of elasticity. Stress diagrams were drawn for each specimen.

### Calibration of Testing Machines.

During the past year considerable work has been done upon the calibration of testing machines.

Four testing machines having a capacity of 200, 4,000, 80,000, and 150,000 pounds, respectively, and one having a capacity of 100,000 pounds, were tested at the navy yard, Washington, D. C., by means of the Emery proving levers.

Other machines and instruments calibrated by this section are the following: Dynamometers, both tractor and recording; tension meter (Crowell); tensiometer (Larson); horizontal Scott testing machine; 10,000 and 50,000 pound Riehle testing machines; 20,000-pound Olsen testing machines; 2 and 8 inch Berry strain gauges; Olsen McAdam impact-testing machines; Upton-Lewis testing machines.

### Circulars of Information.

The following is a brief summary of a few of the letter circulars prepared by Division VII-1.

Letter Circular VII-1-1, "Mechanical Properties of Materials." A great deal of time was spent in the preparation of this most valuable and interesting paper, which contains the best available data on the strengths and related properties of metals, alloys, and certain nonferrous materials. Among the materials treated are iron, carbon steels, alloy steels; wire and wire rope; semisteel; aluminum, copper, and miscellaneous metals and their alloys; rope, rubber, leather, and wood. This circular also includes definitions of the properties treated and references to sources. These data were originally compiled for the Smithsonian Physical Tables, from technical literature, the Bureau's test reports, and other reliable sources.

There has been such a great demand for this paper that it has been prepared for publication as a Bureau circular.

Letter Circular VII-1-2, "Definitions of Mechanical Properties." This gives definitions which govern the more commonly confused terms for properties determined from mechanical tests of materials shown in the tables of Letter Circular VII-1-1, such as P-limit, elastic limit, yield point, ultimate strength, modulus of rupture, modulus of elasticity, Brinell-hardness numeral, Shore scleroscope hardness, and Erichsen value.

Letter Circular VII–1–4, "Standard Test Specimens for Mechanical Properties of Metals." This circular gives a detailed description and a dimensioned drawing of the specimens to be submitted for the determination of different mechanical properties, such as tension, compression, torsion, fatigue, or impact strength.

Letter Circular VII–1–5, "Fees for Mechanical Tests." This circular gives the fees charged by this Bureau for conducting tests for the determination of mechanical properties, such as those mentioned in Letter Circular VII–1–4 above.

Letter Circular VII–1–6, "Parker Variable-Camber Wing." This gives a very good description of a new type of airplane rib recently designed and built at this Bureau, including tables of test results on same.

These circulars have been prepared in mimeographed form, and copies will be sent gratis upon application.

### Publications.

The following is a brief outline of the publications which were prepared by this section:

Physical Properties of Materials, by H. A. Anderson, assistant engineer physicist: A compilation from the best available sources of data on the various physical properties of metals and other non-ferrous materials, with definitions of the properties treated and references to sources.

Test of 150-Ton Floating Crane, by Louis J. Larson and Richard L. Templin, assistant engineer physicists: A description of the methods employed, with analysis and discussion of the results obtained from the strain-gauge measurements taken on many different portions of the crane.

Strength of Spruce Struts, by Prof. James E. Boyd: Experimental data on the strength of spruce airplane struts of uniform cross section, together with the development of the mathematical theory for the design of plain and tapered struts.

The following papers will soon be in the hands of the Publication Committee, as the manuscript is practically complete at this time:

Physical Tests of Motor-Truck Wheels, by Charles P. Hoffman, assistant engineer physicist: Experimental data on radial compression and skid tests of cast-steel, pressed-steel, wrought-iron, and wood wheels.

Strain-Gauge Measurements on the Arlington Building, by Louis J. Larson: Strain-gauge measurements and analysis of the strength and the theory of design of the so-called Schuyster system of fireproof building construction.

### Moving Laboratory to New Quarters in Industrial Building.

During the late winter and early spring, the office and laboratory of this section have been moved to new quarters in the industrial building. To date most of the moving has been completed. There still remain, however, the two Emery machines in the west building and the equipment in the Pittsburgh laboratory to be installed in the new location. These latter need special consideration. All equipment now installed in the industrial-building laboratory was moved under the direction of the section chief. In reinstalling the machines especial care has been taken to so place them as to afford maximum lighting and working space. Further, each machine is being overhauled and readjustments or repairs made wherever needed. This latter was rendered necessary by the strenuous use with minimum repairs of the entire equipment during the period of war.

**Summary of Tests Made by Engineering Materials Section.**

The following statement shows various materials tested by this section during the fiscal year ending June 30, 1919, together with the number of specimens of each type:

*Tests of metals.*

| | Specimens. |
|---|---|
| **Iron and steel:** | |
| Carbon steel | 263 |
| Cast iron | 9 |
| Malleable iron | 6 |
| Nickel chrome steel | 2 |
| Semisteel bars | 3 |
| Strap iron | 4 |
| Welded bars and plates | 150 |
| Total | 437 |
| **Aluminum and aluminum alloys:** | |
| Aluminum alloys | 252 |
| Aluminum, chemically pure | 42 |
| Aluminum solder | 6 |
| Total | 300 |
| **Copper, brass, and bronze:** | |
| Bronze, nickel | 2 |
| Bronze, phosphorus | 7 |
| Bronze, various | 358 |
| Copper | 5 |
| Total | 372 |
| **Miscellaneous metals and alloys:** | |
| Alloy, lead antimony | 19 |
| Alloy, resistant metal | 5 |
| Babbitt metal | 8 |
| Bearing metal | 19 |
| Dental amalgam | 65 |
| Nickel | 8 |
| Tensilite | 1 |
| Total | 125 |

*Tests of wood.*

| | |
|---|---|
| **Various species:** | |
| Cypress | 56 |
| Various | 50 |
| Total | 106 |

*Tests of fiber rope, wire rope, and chain.*

| | |
|---|---|
| **Chain:** | |
| Sash chain | 1 |
| Various | 149 |
| Total | 150 |

| | |
|---|---|
| **Wire, wire rope, and cables:** | |
| Cables, various | 39 |
| Wire, shot-line | 10 |
| Total | 49 |
| **Fiber rope (manila, sisal, etc.): Various** | 66 |

*Tests of other material.*

| | |
|---|---|
| Bakelite type insulating material | 417 |
| Celluloid | 4 |
| China plates | 42 |
| Disks, round | 4 |
| Sapphire balls, bearings for instruments | 12 |
| Shellac composition | 12 |
| Total | 491 |

*Calibration of machines and instruments.*

| | |
|---|---|
| Berry stain gauge | 2 |
| Brinell Hardness specimens | 95 |
| Calibration specimens | 110 |
| Dynamometers | 4 |
| Horizontal Scott testing machine | 2 |
| Larson tensiometer | 9 |
| Lewis-Hayes extensometer | 1 |
| Olsen testing machine | 1 |
| Riehle Bros. testing machine | 2 |
| Standard scale spring | 1 |
| Upton-Lewis repeated stress springs | 13 |
| Total | 240 |

*Tests of fabricated parts.*

| | |
|---|---|
| **Airplanes and airplane parts:** | |
| Beams or spars | 23 |
| Cables | 1 |
| Alloy steel bolts | 6 |
| Gunners' belts | 37 |
| Parachute rings | 7 |
| Pilots' belts | 10 |
| Ribs | 2 |
| Straps | 12 |
| Struts | 37 |
| Wings, veneered | 10 |
| Total | 145 |
| **Wheels:** | |
| Artillery | 6 |
| Steering wheels | 18 |
| | 24 |
| **Guns, shells, powder containers, etc.:** | |
| Ammunition packing cases | 101 |
| Adapters and booster casings | 63 |
| Fuses, nose | 8 |
| Gas shells | 5 |
| Grenades, hand | 1 |
| Gun mount | 83 |
| Gun shells | 64 |

| Guns, shells, powder containers, etc.—Continued. | |
|---|---|
| Gun steel | 27 |
| Mechanism cases | 2 |
| Powder containers | 2 |
| Projectors, steel shell | 3 |
| Rifle barrels | 10 |
| Roller bearings | 9 |
| Shell cases | 4 |
| Shrapnel fragments | 2 |
| Swivels, Browning gun | 9 |
| Total | 338 |

| Miscellaneous: | |
|---|---|
| Abercrombie seal | 7 |
| Acme sealing device | 7 |
| Alloy steel bolts | 14 |
| Armor mesh | 2 |
| Armor plate | 26 |
| Ball bearings | 15 |
| Brass tubing | 2 |
| Canvas covers | 8 |
| Cinchas | 3 |
| Cleavers, butcher's | 8 |
| Condenser tubes | 4 |
| Cord, exerciser | 2 |
| Electrodes | 20 |
| Hammers, steel handles | 4 |
| Handles, rope | 8 |
| Flexible contact for searchlights | 6 |
| Jacks | 9 |
| Lock nuts and bolts | 5 |
| Machetes | 15 |
| Pick mattocks | 2 |
| Piston rings and rods | 8 |
| Reinforcing bars | 58 |
| Rings and staples | 36 |
| Rings, locomotive packing | 20 |
| Scythe blades | 2 |
| Seals, metal | 6 |
| Shield and wire cutter for tank | 1 |
| Springs | 34 |
| Steel fence posts | 8 |
| Steel tubing | 38 |
| Pulleys | 12 |
| Nickel joints | 4 |
| Turbine | 1 |
| Welded specimens | 242 |
| Wire-link fabric | 2 |
| | 639 |
| Grand total | 3,482 |

**Equipment.**

A new apparatus for testing full-length airplane beams has been designed and installed in the laboratory. This apparatus is so built that the airplane beams may be tested under the combinations of loadings (rib loads, pull from guy wires, and thrusts from struts) actually acting on a beam when installed in an airplane.

A 10,000-pound repeated bending testing machine capable of taking specimens 30 inches long and 12 inches wide has been designed and constructed. The machine was originally developed to study the fatigue-resisting properties of electrically welded ship plate.

The great need for an accurate device for the calibration of testing machines has led to the design of a dead-weight calibrating machine that would permit of calibrating testing machines by a standard calibration bar. The present maximum capacity of the machine is 100,000 pounds. While the machine as constructed is not considered ideal, it will, it is believed, be more accurate than anything now used for calibration purposes. The machine has been constructed and is now awaiting assembly and adjustment. In conjunction with this machine, it is proposed to use a standard calibration bar having a 15-inch gauge length and suitably formed ends. This calibration bar of heat-treated nickel steel will be loaded with standard deadweights and its deformation accurately measured. Observations on the deformation of the same bar in testing machines will allow their accuracy to be determined.

A new 50,000-pound capacity, high-standard, Universal testing machine, manufactured by the Tinius Olsen Testing Machine Co. and capable of taking tension or compression specimens 8 feet long, has been installed in the laboratory.

A Brinell hardness testing machine, a gift from the United States Army, and manufactured by the Scientific Instruments Co., of Pittsburgh, has been added to the equipment.

The laboratory equipment has been further augmented by the addition of several extensometers of the Bureau's design, a new recording scleroscope, and a Leeds & Northrup indicating pyrometer.

## CEMENT, CONCRETE, STONE, GRAVEL, AND SAND.

(Investigation and testing of materials for construction purposes; development of new methods of testing; improvement of apparatus for testing; preparation of specifications covering structural materials; development of new uses for cement products; distribution of knowledge as to use of materials; design and fabrication.)

The beginning of the year found the work of this section greatly congested, with practically all of its facilities devoted to war service. The testing and inspection of cement for the Government departments had increased to such proportions that the extension of facilities for this work during the latter part of the preceding fiscal year required still further enlargement, and the normal investigation work had almost wholly given place to emergency research and testing required by the Army, Navy, and by the Shipping Board. Following the signing of the armistice, cement shipments and the corresponding amount of testing fell off markedly, while the military research work diminished more gradually. In the latter part of the year a portion of the prewar investigative work was resumed, but a considerable amount of work initiated by war problems was continued throughout the year and will need to be kept up in the future.

At the close of the year the most serious problem confronting the section was the maintenance of its organization of branch laboratories, two of these (at Denver and San Francisco) having been transferred the year before from the Reclamation Service. These two laboratories should be continued for the very valuable service they are capable of rendering in the West, not only in connection with the inspection and testing of cement and other structural materials but particularly to meet the needs of reclamation and highway work.

### New Branch Laboratories.

The construction of the large Army and Navy supply bases at Brooklyn in the latter half of the calendar year 1918 required nearly 900,000 barrels of cement. This was largely drawn from the mills in the Hudson River district, and in order to meet the testing and inspection requirements of these and other projects, a fully equipped cement-testing laboratory was established at Hudson, N. Y. This laboratory was in operation nearly four months, from August to November, inclusive, 1918. The work in this district was thereafter handled by resident inspectors, the tests being made at the Northampton (Pa.) laboratory in the Lehigh district.

It also seemed desirable to increase the Bureau's testing and investigating facilities on the Pacific coast. After considering the needs of the Army and Navy and the Emergency Fleet Corporation at Los Angeles and San Diego, a very convenient laboratory for chemical and physical work was installed in one of the more permanent exposition buildings at San Diego, where tests of cement, aggregates, and sands, iron, steel, etc., have been in progress since last November. This laboratory has been especially helpful in the construction of concrete ships, and to both the Army and Navy in their construction of aviation fields on North Island. Owing to lack of funds for its further maintenance, this branch will be discontinued July 31, 1919.

On account of the concentration of testing work in the Lehigh district, a well-equipped chemical laboratory was established at Northampton, Pa., to eliminate the delay arising from sending chemical samples to Washington or Pittsburgh. Since the amount of cement tested and inspected in the Lehigh district is always relatively greater than in the other cement-producing districts. this chemical laboratory should be permanently retained.

### Routine Inspection and Testing of Cement.

Shipments of certified cement for Government construction work during the fiscal year were by far the largest in the history of the Bureau. The total shipments for the year amounted to more than 6,500,000 barrels, of which the total cost to the Government was approximately $160,000, or slightly less than 2½ cents per barrel. It may be noted that the cost of this work necessarily included the cost of a large part of the equipment required by the branch laboratories, as well as the actual cost of inspection and tests. It is further interesting to note that the cost of this work alone considerably exceeded the entire appropriation for testing structural materials, only a small portion of which can be allotted to the testing of cement. While the inspection and testing of cement during the next fiscal year for the Government departments is estimated to be only about 35 per cent of the amount required in 1919, it is imperative that the work be provided for by direct appropriation. The reimbursement plan which has been followed as a war measure has proven to be impracticable, and while it will be again necessary to start the new year's work on this basis, it can not be so continued indefinitely. Too much emphasis can not be placed upon the recommendation that the work be adequately provided for, or else abandoned entirely.

The following statement of the quantities of Government-purchased cement certified by the Bureau during the past three years shows clearly how the war affected this part of the work of the structural materials division.

| Month. | Shipments of tested cement in barrels. | | | Month. | Shipments of tested cement in barrels. | | |
|---|---|---|---|---|---|---|---|
| | 1916–17 | 1917–18 | 1918–19 | | 1916–17 | 1917–18 | 1918–19 |
| July | 36,568 | 81,364 | 1,121,960 | March | 54,525 | 335,999 | 311,210 |
| August | 14,941 | 102,259 | 1,053,167 | April | 48,718 | 605,128 | 280,229 |
| September | 58,765 | 146,249 | 1,053,998 | May | 64,325 | 768,395 | 255,646 |
| October | 32,150 | 32,366 | 948,937 | June | 76,646 | 752,161 | 227,857 |
| November | 27,388 | 205,959 | 719,711 | | | | |
| December | 16,012 | 183,406 | 247,137 | Total | 502,845 | 3,597,354 | 6,588,923 |
| January | 29,063 | 113,104 | 186,806 | Rejected cement[a] | 72,000 | 331,000 | 742,000 |
| February | 43,744 | 270,964 | 182,265 | | | | |

[a] The total amount of rejected cement in 1917–18 and 1918–19 was greater than indicated in the table. This is due to the fact that records were not available from two commercial labortories acting for and under supervision of the Bureau in the Middle West and southeastern districts.

The greater part of the cement shipped during the past fiscal year was used on rush work of a military character, such as terminals, forts, factories, shipyards, dry docks, roadways, and bridges. In addition, a considerable quantity of specially ground cement was tested for the concrete ships built under the supervision of the Shipping Board.

Inspection was made at mills in 25 States, as follows: Alabama, California, Colorado, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Maryland, Michigan, Minnesota, Missouri, Montana, New Jersey, New York, Ohio, Oklahoma, Pennsylvania, Tennessee, Texas, Utah, Virginia, Washington, and West Virginia.

### Development of Testing Methods.

During the latter half of the year some progress has been made in systematizing and improving the methods of proportioning materials employed in the laboratory for fabrication of test pieces of mortar and concrete, which it is believed will aid in obtaining more accurate and uniform test results. A study has also been made of the effect of variations in the storage and curing of test pieces. A new method has been devised of measuring the "consistency" or "flowability" of concrete, these terms referring to the somewhat indefinite, but very important, property of concrete mixtures which is primarily dependent upon the amount of water used in mixing.

*Methods of Proportioning.*—Although in the field concrete materials are proportioned by volume, it is essential in the laboratory that weight per cubic foot be known to insure accuracy in duplicating tests and eliminating a variable which may obscure the real differences in strength which should be obtained when comparing different aggregates or in repeating tests with the same aggregate. Often weights are reported as loose weights, determined by allowing the material to fall into the measuring vessel without jarring or tamping. In other cases weights may be reported as packed or tamped weights. The method now employed in the laboratory is to fill the vessel one-fourth of the height and shake and bump until no reduction in volume is apparent, repeating until the vessel is full. The top is then leveled with a straightedge and the net weight determined. The weight used in proportioning and in reporting the result of this test is 95 per cent of the packed weight so determined. Many tests have shown this 95 per cent packed weight to be approximately the average of the loose and packed weights. Since the weight of 94 pounds per cubic foot assumed for cement is approximately an average weight of cement loose and packed, the volume proportions used in laboratory tests are true volume proportions.

*Storage and Curing of Test Pieces.*—In connection with tests of concrete aggregates, observations have been made of the effect of storage and curing conditions on the compressive strength of concrete up to 28 days. Test pieces molded from the same batches of concrete, in every way comparable, were stored in water, in damp sand, and in a damp closet. In general, it may be stated that under properly controlled conditions these methods are equally satisfactory.

The results obtained varied so slightly that for any one concrete the results of all test pieces could properly be averaged. Temperature conditions under all three methods were practically the same, so that with this sometimes variable factor eliminated it may be stated that any method of curing is efficient which permits all water to be retained in the specimen and permits no evaporation to take place. In a humid atmosphere, such as the damp closet, a sprinkling once daily apparently permitted no essential loss of moisture from the mass. This condition should be especially reassuring and satisfactory to drain tile and other cement-product manufacturers, since it shows that closed rooms kept moist by occasional sprinkling during the curing period, furnish efficient means of storing these products. It should not be assumed from this that additional benefit will not be derived from a well planned and operated system of steam curing.

*Flowability of Concrete.*—Work which has been done in the laboratory in connection with tests of methods of proportioning concrete mixtures emphasizes most strongly the importance of being able to measure and express the important and fundamental quality of flowability of concrete. In actual work some minimum flowability must be attained, and laboratory concretes should be made with this requirement in mind, since on the job, if the concrete does not have sufficient flowability, more mixing water will be added. Such a property and condition is a necessity, but it is well known that increase in water lowers strength. Therefore, it is essential that aggregates tested in the laboratory should be tested in concretes having the same conditions of flow. Otherwise, misleading and incorrect conclusions will be drawn as to their relative values for concrete making.

In the last annual report a method for determining the consistency or flowability of concrete in the field was described. The apparatus consisted of a piece of cylindrical tubing 6 inches in diameter by 12 inches high, which was filled with freshly-mixed concrete and then withdrawn vertically from the mass. The amount of settling of the unsupported concrete depended upon the amount of water used, and was, therefore, a measure of consistency. This test, commonly known as the "slump" test, was fairly well adapted to the rich mixture employed in ship and highway construction, but was found to be unsuited to the leaner and widely varying types of concrete which are encountered in the testing laboratory.

The flowability is now measured by molding a mass of concrete on a metal-covered table whose top can be raised a fixed height by means of a cam and dropped. The resulting bump will cause the concrete to spread in circular form, concentric with its original outline, the increase in diameter after a given number of repetitions of the bump being a measure of its flowability. Tests to determine the best form of test piece, as well as the height and number of drops, are still under way, but a number of interesting facts are already apparent. It is found that whatever the proportion of cement to aggregate, whether a 1—1—2 mix or a 1—3—6 mix, increase in flowability is proportional to increase in percentage of mixing water. Definite figures for flow can be obtained for concretes too dry for any ordinary practical purpose and also for concretes so wet that they would be ruled off of any properly inspected work. This variation in flow with increase in percentage of mixing water is essentially a straight-line relation within the limit of practical working mixes.

Some work has also been done with an apparatus of this type in determining the consistency of cement pastes, which is a fundamental step in the ordinary testing of Portland cement. While a comprehensive program of experiments has not yet been carried out, it may be stated that the method promises to be of higher merit than either the Vicat or ball methods now prescribed in the specifications.

### Design of Concrete Mixtures.

During the past year two new theories of proportioning concrete aggregates have been advanced. One of these theories is based on the assumption that the ratio of the volume of mixing water to the volume of cement in a concrete mixture determines the strength; that the grading of the aggregate is important only in so far as it affects the amount of mixing water; and that aggregates having the same "fineness modulus" (which may be regarded as a measure of the average or effective fineness), even though differing widely in gradation of sizes of particles, will produce concretes requiring the same amount of mixing water, and consequently having the same consistency and the same strength. The second theory is based on the assumption that if the amounts of both cement and water in concrete mixtures are properly proportioned to the total surface areas of the aggregates, concretes of the same consistency and strength will be obtained.

A considerable amount of work has been done by the Bureau in checking the validity of these theories, particularly in so far as they relate to the predetermination of the strength of concrete. In the studies which have been made thus far it has been established (1) that slight variations in the amount of mixing water have a relatively large effect on the flowability and strength of concrete; (2) that the amount of water required in a concrete mixture must from practical considerations be based on a definite degree of flowability; (3) that the amount of water required in a concrete mixture can not be determined by the formulas accompanying the theories referred to, nor at the present time by any known method other than by trial with a suitable apparatus for measuring the flowability of a concrete mixture. A great deal of effort has therefore been devoted to the development of an apparatus of this kind, which has been described in some detail in a preceding paragraph. By means of this apparatus it has been demonstrated that the water required to gauge a concrete to a definite degree of flowability unquestionably depends upon the surface area of the aggregate, regardless of its fineness modulus; to precisely what extent this and other factors enter has not yet been determined.

A discussion of the results of this investigation has been published in the technical press and reported to the American Society for Testing Materials.

**Fineness Investigation.**

Under this heading may be included the determination of the properties of finely ground cements, the determination of the gradation of finely divided materials by means of the air analyzer, the standardization of testing sieves, and the preparation of standard cement samples.

*Higher Strength from Finely Ground Cements.*—On behalf of the cement committee of the American Society for Testing Materials, a considerable amount of time has been given to the tabulation of existing data on the increased strength obtained in concrete from the use of more finely ground cements. An attempt also has been made to obtain data on the costs of finer grinding, with a view to determining, if possible, whether a further increase in the fineness requirement of the standard specifications is warranted. So far as increased strength is concerned, the fairly definite conclusion has been reached that 1 per cent increase in fineness yields very approximately the same increase in strength as an addition of 1 per cent in the quantity of normally ground cement. The cost data are inconclusive, not only because the estimates obtained differed widely, but mainly because so many factors have to be considered in determining the value of the estimates. It may be stated, however, that the majority of the figures submitted were based on loss of production occasioned by finer grinding, assuming the mills to be operating at full normal capacity. Taking the figures at their face value, the average increase in cost to the consumer appears to be nearly the same, whether he pays the higher price for finer cement or the increased cost of a larger quantity of normally ground cement.

An opportunity was obtained during the year to make tests of an unusually fine cement put upon the market by a progressive manufacturer. The increase in strength obtained in comparison with the normally ground cement was marked, and it was readily demonstrated in this particular case that the intelligent user could save money and get a better product by using the finer cement. The investigative value of these tests, however, lay chiefly in the fact that general results differing from those of similar tests in the past were obtained; for example, a very great gain in strength of the richer mixtures, but a less marked increase in the leaner mixtures. It is not known whether this reversal is a peculiarity of the material or whether in the decision to base all concrete tests upon accurately controlled field consistencies the results obtained were characteristic of the wetter mixtures. The entire series with this and other cements of high fineness will be repeated.

*Air analyzer.*—Throughout the period of the war pressure of other work prevented further development or improvement of the air analyzer. This apparatus is used for the mechanical analysis or size gradation of finely divided materials. During the past year it has been used in the mechanical analyses of various materials under investigation by the Bureau, particularly normal cements, blended and reground cements, and cements ground by a new type of mill. It is believed that the air analyzer may be adopted for mechanical analyses of other materials than cement, as clays, mineral powders, abrasives, pigments, explosives, etc. It is hoped that original research for the wider use and development of the air analyzer may be resumed at an early date.

*Standard Cement Sieves.*—During the year 56 200-mesh sieves were standardized. In the annual report for 1918 it was indicated that it had become difficult to obtain 200-mesh sieves that would meet the Bureau of Standards' specifications. During the present year there has been a decided improvement in the quality of sieves submitted to the Bureau for standardization. When the war came on the American manufacturers were cut off from the their European sources of supplies of 200-mesh cloth and manufacture of the latter was taken up in America. The American cloth was made of somewhat different material from that obtained in Europe and presented new problems and difficulties in weaving. Apparently these difficulties are being or have been overcome, and it is now possible to obtain sieves meeting the specifications of the Bureau.

*Standard Fineness Samples.*—The Bureau continues to issue standard fineness samples of cement for checking up 200-mesh sieves. These are supplied in two degrees of fineness, 46–e, 80.2 per cent passing the standard No. 200 sieve, and 47–b, 88 per cent passing the standard No. 200 sieve. These samples are issued in sealed glass jars, each containing about 160 grams of cement. Each sample is accompanied by full directions for its use. With these samples, 200-mesh sieves may be compared with the fundamental standards and correction factors obtained. During the year 134 samples were issued to owners of No. 200 mesh sieves, a nominal price being charged for each sample. There has been an increased demand since the end of the war, 110 of the above samples having been issued since January 1, 1919. About 150 of these samples were used by the Bureau in standardizing sieves submitted, and checking up its own 200-mesh sieves.

### Volume Changes in Mortars and Concretes.

The study of volumetric changes in mortars and concretes was largely set aside during the war, and the present program was undertaken only at the beginning of the calendar year. The work has been confined entirely to the laboratory, and special stress has been placed on determining the volumetric changes that take place in mortars during and following the time of setting. Up to date the Bureau has dealt mainly with volumetric changes in 1-to-3 and 1-to-4 mortars and other typical stucco mixtures. Early in the work considerable study was made of the methods and apparatus for determining the volumetric changes, and it is gratifying to state that the Bureau has been able thereby to get accurate and consistent results. Although over 50 specimens have been made up and placed under test, it is yet too early to draw any definite conclusions, since observations are still being continued on most of them.

It is the purpose of these investigations to determine, first, the exact amount of volumetric change in the various materials; second, the causes of these changes; and, third, a remedy or way of offsetting these changes without losing any of the intrinsic and necessary value of the material. The extreme importance of these investigations has been brought out even in our preliminary tests, as several mixes have shown such serious cases of contraction that would seemingly prohibit their use as structural materials in their present form. As soon as tests are comprehensive enough it is the intention to make a published report of results.

**Concrete Oil Storage.**

During the past year three main series of tests have been conducted to determine the limitations of untreated concrete tanks for the purpose of storing oils.

Series I consists of eighteen 1:2:4 concrete tanks in which were stored 11 mineral oils with gravities varying from 0.742 to 0.959—that is, from commercial motor gasoline to a very viscous residuum oil—5 vegetable oils, and 2 animal oils. In each tank were placed three 6 by 12 inch concrete cylinders, to be broken after an exposure to the various oils. This series was started to determine the volumetric loss of oil due to absorption and penetration of the oils, but it was found that the physical properties of the oils and the temperature changes played such an important part in determining accurately the loss that these tanks were kept under test as qualitative rather than quantitative tests.

After a year's exposure to the various oils, the concrete of the tanks and cylinders is apparently unaffected, with but two exceptions. The surfaces of the tanks containing cocoanut and lard oils have been attacked and are considerably roughened. The cocoanut oil was more active than the lard oil, but neither has affected the concrete to a greater depth than one thirty-second of an inch, and the penetration observed when the cylinders were broken was 0.2 inch in both cases. The breaking strength of the 6 by 12 inch cylinders showed only a slight decrease when compared with the strength of cylinders stored in air.

Series II and III consist of quantitative and qualitative tests on 1:⅔:1⅓ concrete tanks, in which the maximum-sized aggregate is one-half inch. The tanks of Series II are under no head, while those of Series III are under a 25-foot head of oil. The oils used in these tests were vegetable and mineral oils, the latter having gravities varying from 0.649 to 0.970; that is, from very light gasoline to a heavy residuum oil. It was found the losses were greater the lower the specific gravity; that where the specific gravity was 0.875 or higher the losses were very small. The head of oil had relatively little effect on the rate of loss.

In the tanks of Series I and II that contained boiled and raw linseed oils a very noticeable deposit of lime soap was observed. This was more marked in the case of the boiled than in that of the raw oil.

Additional experiments are being started along the same line on 1:1½:3 tanks preparatory to taking up the question of oil-proof coatings to determine their relative worth for treating concrete tanks for storing the lighter oils, for it is evident from the results obtained thus far from the tests that concrete tanks properly constructed are practically impervious to oils with gravities of 0.875 (30° B.) or heavier.

## Waterproofing Concrete.

Although hampered by a very large amount of war work, the Bureau endeavored to carry out a waterproofing test which had been on its program since 1916. This test called for the construction of three concrete tanks below water level near the Potomac River, the tanks to be built by a local contractor under supervision of a representative of the Bureau. The tanks were to be constructed of 1:2:4, 1:2½:5, and 1:3:6 concretes, respectively, each with 8-inch walls and bottom, 5 feet square, and 10 feet deep, built in a pit, to be kept dry during the work and for a period of two weeks thereafter. The forms were then to be stripped, the pit allowed to fill by seepage, and the water-tightness of the tanks to be determined. This program was carried out in October, 1918, and all three tanks failed in the test. This result was practically assured as soon as the forms were removed, for the concrete had not filled properly around the reinforcement near the bottom, and pockets of considerable size were left near the junction of walls and bottom in all the tanks. For this reason, the test did not serve its intended purpose, which was to demonstrate whether any of the three mixtures would make a waterproof job without the use of integral waterproofing.

An experiment of this kind focuses attention upon the difference between laboratory and field tests of a material such as integral waterproofing. In the laboratory it may be assumed that workmanship is perfect, and the actual merit of the material can be determined by comparative tests of treated and untreated concrete. Quantitative experiments of this type should furnish valuable information, and such experiments will be carried along in connection with the laboratory work of the concrete oil storage investigation, in which the nature of the tests, equipment required, etc., are exactly the same. In the field, workmanship is an uncontrolled variable, which, if it could be measured, might be expressed as a definite fraction or percentage of perfect workmanship. The field test is, therefore, one of waterproofing versus workmanship, of which the results must be inconclusive. To what extent the use of waterproofing compensates for poor workmanship can be determined only to the degree that the latter is capable of measurement.

## Stucco.

The work of this investigation has been confined to the application of experimental stuccos to three penthouses on one of the new laboratory buildings of the Bureau. Two of these were coated with 1:4 and 1:6 mixtures of cement and crushed gravel screenings, respectively; the third was an experiment with exposed aggregate finish in which aggregate up to one-fourth of an inch in size was used. All of these were very successful and, in comparison with the richer mixtures commonly specified, are a distinct advance. During the year a recommended practice for Portland-cement stucco has been prepared by the committee on treatment of concrete surfaces of the American Concrete Institute, in which the results of the Bureau's investigation have been embodied.

### Durability of Concrete in Alkali Soils and Waters.

This investigation has been suspended since 1916 owing to press of war work. Plans have been completed to resume the field work in the fall of 1919, which will include tests of drain tile previously placed in the alkaline soils of the western United States as well as inspection of test blocks and various concrete structures. The advisory committee which has been assisting in formulating the program of tests, as well as in the conduction of the field work, has been increased by the appointment of members to represent the American Concrete Pipe Association, the Portland Cement Association, and the Engineering Institute of Canada. Cement drain tile for replacement in the drains in 1919 have been made at a factory in Muscatine, Iowa, under the supervision of the American Concrete Pipe Association.

### New Material for Increasing Rate of Hardening of Cement.

Considerable work has recently been done on "Cal," which is a new material for increasing the rate of hardening of cement mixtures. It is essentially an oxychloride of calcium in the form of a dry, white powder. It is not delequescent, as is calcium chloride, and can be packed in bags and handled in much the same manner as hydrated lime. "Cal" is added to the concrete materials at the time of mixing, and is quickly decomposed by the water into calcium chloride and calcium hydrate, the calcium chloride going into solution, while the calcium hydrate largely remains in a solid, but very finely divided, form. Thus, the beneficial effects of calcium chloride as to workability and increased rate of hardening of the concrete are obtained, together with the probable effects of calcium hydrate as to increased workability and decreased permeability.

The greater part of this work up to the present time consists of compression tests on 2-inch mortar cubes. These tests indicate that different brands of cement respond to the action of "Cal" to a greater extent than others. The brand least affected gave a strength in 3½ days equal to the 7-day strength of the untreated mortar, the treated mortar containing an amount of the material equal to 5.5 per cent of the cement. The brand most affected by the same treatment gave a strength in less than 2 days equal to the 7-day strength of the untreated mortar. The above results were obtained on test pieces stored in water. Test pieces stored in the laboratory air gave much more favorable results, the treated mortar giving a strength in about 2 days equal to that of the untreated mortar at 28 days. This indicates that "Cal" would be very effective in concrete construction exposed in any way to the drying-out action of the air or sun, and in places where it is difficult or impracticable to keep the concrete continually wet during its early hardening.

The investigation is being continued with concrete, using various mixes and 6 by 12 inch cylinder test pieces. Corrosion tests have also been started. Sufficient data have not been obtained from these tests to make any conclusions possible.

### Acceleration of Hardening of Concrete by Steam.

Experiments were made to determine how strong a 1:2:4 concrete could be produced in 48 hours, using steam applied internally and externally to the mass of concrete. These tests were made at the request of the Inventions Section Army War College. Twelve-inch cubes of concrete were subjected to the following methods of curing: Indoor air, external steam, steam flowing through embedded, perforated pipes, steam flowing through nonperforated pipes. Use of perforated pipes proved impractical, due to clogging of the pipes. All three methods of steam curing gave practically the same strength at the end of 48 hours. This strength was from 200 to 400 per cent of the strength of air-cured concrete of the same age, depending upon whether cured indoors or outdoors, and was about equal to the strength of air-cured concrete seven days old.

### Automatic Freezing and Thawing Apparatus.

This apparatus, designed for the purpose of making extensive weathering tests on building stones, concrete, bricks, etc., has been experimented with to a considerable extent during the latter part of the year. Forty-eight freezings and thawings can be made in one day, but owing to difficuties experienced in keeping the specimens damp the frost action is not as rapid as desired. Some changes are being made in the apparatus in order to overcome this difficulty.

### Investigation of Building Stones.

Extensive tests are being made on Indiana limestone to establish data for a more definite grading of the material and to determine the relative value of the different grades. Tests have been made on 72 samples of the material. Some work has been done on granite in connection with the cooperative investigation of building stones. Tests were made on several samples of quartzite, in cooperation with the United States Geological Survey, to determine its suitability for use in nitro-acid towers. Some time has been given to the study of the thermal expansion of marble for diurnal temperature changes. The results indicate that there is a slight permanent increase in dimensions of newly quarried marble when subjected to the weather. A report of the Bureau's work on the commercial marbles of the United States has been issued as Technologic Paper No. 123.

### Service Tests on Floors and Concrete-Floor Treatments.

Several rooms in the Bureau's buildings have been surfaced with congoleum and mastic flooring, giving a variety of service conditions on these materials. These materials are being studied under the various conditions of use.

Numerous inquiries have been received during the past year concerning the value of different treatments for concrete-floor surfaces to prevent dusting. In order to secure reliable information on this subject, an investigation has been started which consists of service tests on a number of floor panels treated with different materials. These panels are being carefully noted at intervals and compared with sections which were left untreated. The treatments under test may be classified as follows: Magnesium fluosilicates, paints and varnishes, waxes, and miscellaneous treatments, such as soap, linseed oil, sodium silicate, and alum. The majority of the treatments have been beneficial, the fluosilicates and sodium silicate being perhaps worthy of special mention. All paints and varnishes have been satisfactory and require longer exposure to traffic to demonstrate their relative durability.

### Reinforced-Concrete Investigations.

A large portion of the investigational work in reinforced concrete has been carried out for the Concrete-Ship Section of the Emergency Fleet Corporation under the direction of a member of the Bureau's scientific staff. Details of this investigational work are given in the following paragraphs. A paper giving a summary of the most important of this work was presented at the annual meeting of the American Concrete Institute, June, 1919.

*Corrosion Tests of Reinforcing Steel.*—The corrosion tests were made to obtain information relative to the importance of corrosion of the reinforcement in concrete ships and to methods of preventing or mitigating corrosion of the reinforcement. About 20 proprietary coatings, including paints and asphalts, were used as protective coatings, and salt-spray tests were made to determine their effectiveness. Many of the coatings were found to be effective in preventing corrosion, but to have serious effect in reducing the bond strength of steel when embedded in concrete.

*Bond Tests.*—Pull-out tests of specimens, consisting of steel bars coated with the protective coatings previously referred to, were made on about 400 specimens. These tests showed that practically all coatings, even including metallic coatings such as zinc, had a deleterious effect on the bond strength (the resistance to slipping through the concrete) of bars embedded in concrete.

*Repeated Reversal of Load on Reinforced-Concrete Beams.*—The tests reported in the Annual Report for 1918 on double-reinforced-concrete beams loaded in alternate directions have been carried further. Four beams have been tested to failure, and in all cases failure was by tension in the steel. One beam which has had 2,000,000 applications of the design load shows no indication of the approach of failure. In one beam there was a large amount of slip of a reinforcing bar before failure occurred. Within the limit of these tests there is no indication that the strength of a doubly reinforced-concrete beam (reinforced for bending in opposite directions) is determined by the properties of the concrete, if the ordinary requirements of design are met, unless it be that of the bond stress. The abrasion of the concrete at the edges of cracks in reinforced-concrete ships was considered as a possible danger, and the tests were initiated to obtain information on this subject. There is no indication that this is a real danger. Not all the tests originally planned have been completed. The danger of slipping of bars either where they are lapped at the center of the span or where at the end of the beam they do not have anchorage by hooking of the bars is one which should be investigated and on which certain of the tests already planned should give information.

*Impact Tests on Concrete Slabs and Built-up Steel Plates.*—In an effort to secure a basis for comparison of resistance of concrete slabs and steel slabs to impact, tests were made in which the impact was furnished by dropping a 1-ton ball upon the center of the slab. Eight reinforced-concrete slabs and one steel slab designed to represent conditions for the shells of reinforced-concrete ships and of steel ships, respectively, were tested. Six of the reinforced-concrete slabs were 6 feet 6 inches by 7 feet in size, and two of them were 10 by 10 feet. The steel slab was 12 by 10 feet 2 inches in size.

*Leakage of Water Through Cracks in Reinforced-Concrete Shell.*—Early in the investigation of shearing strength of reinforced-concrete beams it was found that cracks were likely to form when shearing stresses were considerably lower than those which it seemed necessary to use in the design of concrete ships; yet it was not known whether these cracks were such as would permit leakage of water through them or not. Tests were made in which hollow beams were loaded in such a way as to cause diagonal tension cracks in the side walls at the same time that the beam was filled with water, which was maintained under pressure varying in head from 15 to 30 feet. These tests indicated that the smallest crack which could be detected, say, 0.001 inch or less in width, would permit the passage of enough water to cause a moist surface on the outside around the crack. As the crack width increased the leakage increased rapidly, provided that time was not given for the closing up of cracks by the deposit of sediment of any kind. When the crack was 0.01 inch wide water spurted clear of the outer surface of the beam. When the beam was allowed to stand overnight with the pressure head and the load maintained the leakage was decreased markedly. This was probably due to the deposit of a substance which helped to fill up the cracks. Further indication of this was shown by the appearance of efflorescence on the surface of the beam in the neighborhood of the cracks. If the cracks had been very small at the time of their formation and had developed very slowly, it is possible that the silting would have kept up with the opening of the cracks and that leakage would not have occurred. Apparently this is what has happened with some of the concrete ships and barges which are afloat. An inspection made on a concrete ship which had been in the water about a year showed the presence of cracks which were large enough to cause leakage under the conditions to which these test beams were subjected. However there was no leakage, although the cracks were below the water line, and apparently there had been none. There was efflorescence apparent at cracks on the inside of the hull, indicating that the process of silting had been taking place.

*Sheer and Compression in Reinforced-Concrete Beams.*—These tests were begun as a part of the study of reinforced concrete in adapting it to use for the construction of concrete ships. One of the first serious difficulties in the designing of concrete ships was that of getting sufficient strength to prevent cracks forming diagonally in the vertical sides of a ship of practicable weight. Using the methods ordinarily employed in reinforced-concrete design, a shell thickness of at least 15 inches would have been required instead of the 4 inches used in the 3,500-ton cargo ship. Tests of large reinforced-concrete beams were started to make certain that no mistake was being made in using a 4-inch shell. These first tests were made on (*a*) beams 4 feet 4 inches deep and 18 feet 6 inches long; (*b*) one beam 10 feet deep and 22 feet long; and (*c*) specimen ship frames of full-sized scross section and 20-foot span. The frames were cut off at a point corresponding to the point of inflection, or 4 feet 6 inches above the top of the keel. The tests were made in the 10,000,000-pound testing machine at the Pittsburgh laboratory of the Bureau of Standards.

For the beams the load was applied at the center of the span upon the upper flange. The beams were supported at each end on a steel-plate girder. The beam, 10 feet deep, was first loaded 40 times with 640,000 pounds, which was four times as much as the maximum which the standards of the joint committee on concrete and reinforced concrete would have allowed as its working load. The widest crack at the first application of this load was 0.013 inch, and with 40 repetitions of the load, there was no appreciable increase in the widths of the cracks. The beam was then inverted and load was applied in the opposite direction, causing failure at 1,363,000 pounds, or nine times as much as the joint committee standards for reinforced-concrete design would have allowed as a working load.

The ship frames were tested by applying first only a vertical load and adding later a horizontal load at the sides corresponding to the horizontal water pressure on the sides of the ship. It was found that the strength here was about eight times as great as the joint committee recommendations allowed for the working load, also that the shear due to the horizontal forces reduced the stresses set up by the shear due to the vertical forces; in other words, that the horizontal water pressure would reduce the stresses caused by the vertical shearing forces on the frame.

These tests made it possible to design with confidence for shear in reinforced-concrete ships, using working stresses much higher than those which are recognized by the final report of the joint committee. In effect, the joint committee report limits the amount of web reinforcement to about three-fourths of 1 per cent, while these tests show that for deep beams a much larger amount of reinforcement would be effective. Apparently the main reason for the higher shearing strengths found in these tests is the larger percentage of web reinforcement which may be used effectively in deep beams where the web bars have much better chance for anchorage than in shallow beams.

After these preliminary tests were completed a more nearly exhaustive investigation was initiated at Lehigh University, Bethlehem, Pa., for the Concrete Ship Section of the Emergency Fleet Corporation.

In the economical use of building materials the importance of using higher shearing stresses in reinforced-concrete beams has been recognized by many. The results of the tests made for the Concrete Ship Section were so significant in this direction that the Bureau of Standards continued the investigation after the program of tests as related to concrete ships was completed. In all 172 beams have been tested, and the results have been quite fully worked up, giving data for a technologic paper which should be of much importance to the reinforced-concrete industry.

The conclusion from these tests is that not only working stresses in shear may properly be increased, but that they may be increased to such an extent that other features of the design become the controlling features. In order to make use of the high shearing stresses permitted, compressive stresses would be increased beyond all present reasonable values. This led to the making of tests to determine if an increase in compressive stresses was permissible. These tests were only four in number and not sufficient to afford a basis for a general conclusion, but, so far as they go, they indicate that higher working stresses in compression than are now generally recognized could be used with safety. It is important that further tests of this kind be made.

*Reinforcement for Concrete Slabs.*—There has been much uncertainty as to the relative economies of reinforcing slabs with (*a*) bars in the direction of the span, (*b*) bars making some angle with the span, and (*c*) expanded metal. Twenty-six slabs 4 inches thick were tested, in each of which one of the three methods of reinforcing described above was used. The results as they stand indicate that the largest amount of steel is required in the case in which the bars are placed diagonally with the span, and that as regards quantity of steel required there is a slight advantage for expanded metal over the use of bars in the direction of the span. However, certain conditions of the tests make it important that more tests be made before this question is considered to be settled.

*Length of Lap Required for Reinforcing Bars.*—Tests were made to determine how great a length of lap is necessary for cases in which the reinforcing bars used are shorter than the span and are spliced by lapping them in the center of the span. Four beams were made in this series, and the indication from the test results is that for this size of bar (one-half inch round) a lap of about 50 diameters is required. The concrete used in these beams had a strength of about 5,000 pounds per square inch, and it is to be expected that with a leaner concrete a larger lap would be necessary. Some information from tests in which expanded-metal reinforcement was lapped in the same way is available. As to quantity of steel required for the lap, this indicates a slight advantage in favor of expanded metal.

*Value of Brackets and Haunches in Flanges.*—For purposes of architectural effect, or for increasing the strength, connections between columns and beams are frequently provided with brackets. This development sometimes takes the form of an arch construction. However, in the design little attempt is usually made to determine how much strength is added by the presence of the haunch, and usually advantage is taken of only a portion of the value of the haunch or bracket. In the design of reinforced-concrete ships the strength value of such brackets is of much importance. To obtain information on this subject, a series of tests was made, including as test specimens eight reinforced-concrete frames having a span of 14 feet, a height of 7 feet, and brackets ranging from no bracket to one so large as to give the appearance of an arch. These tests indicated that the brackets had much more value in strengthening the frames than that for which allowance is usually made in the design. The results are of much importance, since the weight of the frames in a concrete ship can be reduced materially by taking full account of the strength added by the brackets in the frames. If the results are adapted to general design in reinforced concrete, they will have an important bearing on the reinforced-concrete industries where such structures are involved.

*Shrinkage of Concrete in Setting as Related to Concrete-Ship Construction.*—It is recognized that shrinkage of concrete occurs during setting. In many constructions this is manifested through cracks which appear in the concrete surface, but the laws which govern this shrinkage have not been very thoroughly determined. This subject becomes important in connection with the concrete ship, since, as pointed out in a previous paragraph, the smallest cracks will permit a slight leakage unless silting prevents it. In one of the barges constructed by the Emergency Fleet Corporation for the Inland Waterways Commission a series of careful measurements was made in the effort to determine why more frequent and larger cracks occurred in this barge than occurred in the others. While the effort was not entirely successful, the measurements did show that there was an elongation and shortening of the barge which corresponded closely to even the slightest rise and fall of temperature. With any rise in temperature the cracks began to close, while with a decrease in temperature the cracks opened. The largest crack present was less than 0.01 inch, and although the barge was not loaded the results of examinations of concrete ships which have been in service indicate that a deposit of silt or efflorescence will prevent leakage through cracks of this size.

*Reinforced-Concrete Freight Car.*—During the year a gondola freight car with superstructure of reinforced concrete was designed and built by J. B. Strauss, consulting engineer, Chicago. During the construction of this car a representative of the Bureau of Standards advised with Mr. Strauss and made an inspection of it after its completion and inauguration into service. After the car had been in service about three months, during a part of which time it was used for hauling coal. an inspection of it was made at Washington by representatives of the Bureau. This indicated that although there was some abrasion of projecting parts, this car had stood up fairly well under service conditions.

*Reinforced-Concrete Flat-Slab Design.*—Several urgent applications for investigational work on the reinforced-concrete flat slab have been made by those commercially interested. With two exceptions it has not been possible to make these investigations on account of the interference with war work. Plans have been projected by which a long series of tests of slabs conforming to various designs would be carried out. An expression of the willingness of certain interested concerns to cooperate in this work has been secured, but at the present time funds are lacking with which to meet the part which it seems proper that the Bureau of Standards should assume. One of the investigations now under way would have afforded a good starting point for this investigation, but the lack of funds to carry out the work together with the importance of starting the present investigation at once rendered this impracticable.

The controversy over the proper moment coefficients for flat slabs is acute throughout the country, and a thorough investigation of their merits should be made. The expense is too great for any one commercial concern to undertake it alone, and the competition between proprietary interests has been so great as to prevent cooperation among them to accomplish this purpose. The recent expiration of the basic patents on the flat slab will tend to remove this restraint, and it seems feasible to obtain cooperation of those commercially interested in this problem to the end of making a thorough investigation.

### Miscellaneous Concrete Investigations and Tests.

*Light-weight aggregates.*—The investigation of light-weight aggregates for concrete ships begun during the past year was continued. Twelve burnt-clay aggregates were tested, these tests aiding in the selection of a light-weight aggregate by the Emergency Fleet Corporation for use in concrete ships. The aggregate produced commercially was a light-weight burnt clay made by "puffing" or "bloating" a clay or shale in a stationary brick kiln or a rotary cement kiln.

The Bureau tests of the best varieties of this aggregate showed that it would give a satisfactory strength (from 4,700 to 5,700 pounds per square inch at 28 days) when used in a 1:⅔:1⅓ mix and would give a concrete weighing from 110 to 115 pounds per cubic foot (about three-fourths as much as ordinary concrete). Tests were also made using these light-weight aggregates in 1:1:1 and 1:1:2 mixes. During the investigation several varieties of slag were tested and generally gave satisfactory strength results, but did not produce so light a concrete. Coke as an aggregate gave light concrete, but was slightly inferior in strength. Seven varieties of vesicular, basaltic, or volcanic rocks were tested for this purpose. In general, these give satisfactory strength, but produced slightly heavier concrete than the clay aggregates. Several other rock aggregates were tested.

Permeability tests were made comparing several of the clay aggregate concretes, with sand-gravel concrete of the same mix, and, although the tests were limited and not conclusive, they indicate that the concrete made of clay aggregates is at least as impermeable to water as that made with sand and gravel. Absorption tests show that clay-aggregate concrete is more absorptive than sand-gravel concrete. For a 1:1:2 mix, sand-gravel concrete showed 8 to 10 per cent absorption in terms of dry weight, while clay-aggregate concrete gave 12 to 18 per cent. Tests showed that the modulus of elasticity of clay-aggregate concrete is slightly slower, but nearly the same as that of concrete made of sand and gravel.

*Cement Gun.*—An extensive series of tests was made on gunite in cooperation with the United States Shipping Board to determine the suitability of this material for use in concrete ships. The different phases of the question investigated were as follows: The effect of shooting the material in a number of layers at different intervals, the effect of shooting the specimens in vertical and horizontal positions, the strength of different gradations of the aggregate and different proportions of cement to aggregate, the effect of different pressures for shooting the material, the effect of shooting the material through screens composed of various sizes and spacings of reinforcing rods, and the comparison of the concrete made with the cement gun and the same made by the usual process. Strength tests were made both perpendicular and parallel to the direction of shooting. The series consisted of 175 slabs of the material which were sawed into test specimens on the machines in the laboratories of the Bureau.

The report on this investigation is being prepared by the Concrete Ship Section of the United States Shipping Board, and no analysis of the results has been attempted by this Bureau. However, an interesting feature of the tests which stands out quite clearly may be mentioned, viz., that the gunite specimens showed a marked increase in compressive strength over concrete slabs fabricated in the usual manner. This increase for the different proportions and gradations ranged from 23 to 70 per cent. One explanation of this probably lies in the fact that the gunite can be placed in a drier consistency than that required for pouring.

*Concrete Atomizer.*—A series of tests was made on concrete fabricated with the Brown atomizer. This investigation was also made in cooperation with the United States Shipping Board to determine the suitability of the material for use in concrete ships. The phases of this question investigated were as follows: Effect of various proportions of cement to aggregate, effect of different consistencies, the effect of different pressures of shooting, effect of blowing the specimens with cold air (i. e., at outdoor temperatures), hot air, steam, and a mixture of steam and hot air. The specimens were made by shooting the concrete in forms which were divided into compartments by horizontal and vertical rods. After the concrete had hardened sufficiently the rods were drawn, which permitted the specimens to be easily broken out from the slab. Satisfactory results were obtained by blowing specimens with both cold air and hot air, but the ones blown with steam were not satisfactory on account of too much water of condensation entering the concrete. This was thought to be due to the fact that a long steam pipe was used without insulation. The report of this investigation will be published by the United States Shipping Board.

*Field Control of Concrete Used in Concrete Barges.*—A representative of the Bureau aided in the control of the concrete that was used in the initial pourings of the New York State Canal concrete barges that were being constructed for the Railroad Administration supervised by the Emergency Fleet Corporation. This consisted of laboratory tests of the aggregates to be used, the regulation of the mixture and consistency on the job, and the taking of test cylinders of the concrete actually placed.

*Corrosion of Reinforcement Due to Use of Calcium Chloride in Gauging Water.*—Plain and galvanized wire mesh embedded in slabs of 1:2 and 1:3 river-sand mortar gauged with plain water and with a 4 per cent solution of calcium chloride showed that at the end of two years the corrosive effect of the salt introduced into the mortar was very marked. Plain wire mesh embedded in 1:3 mortar was attacked the most, being completely eaten through in places. The galvanized metal was attacked seriously, although not as badly as the plain mesh. The metal embedded in 1:2 mortar was not so badly attacked as that embedded in 1:3 mortar. In all cases of the metal, both plain and galvanized, embedded in mortar gauged with plain water, the reinforcement was in excellent condition and was not rusted and demonstrated the protection afforded by Portland cement. A comparison of the condition of the reinforcement embedded for two years and that embedded for one year showed that the rusting due to calcium chloride was progressive and becomes worse with age. Reinforcing rods embedded in 1:2:4 and 1:1½:3 concrete made with and without calcium chloride also showed a corrosion due to the calcium chloride, but to a somewhat lesser extent.

*Paper Molds.*—A paper mold for use as the form in which to cast 6 by 12 inch concrete test cylinders was developed for use in molding samples of field concrete. The distinctive improvement in the mold is that it is slit lengthwise in order to allow nesting during shipment and that it can be assembled at the job by lacing up with a stapling machine. Each paper mold weighs only 7 ounces (one-fiftieth as much as a steel mold of the same size), and 25 of them nested for shipment occupy only about as much space as a steel mold and weigh half as much. A two-ply cardboard cylinder, such as is usually manufactured, slit lengthwise, and then dipped in paraffin, to make it waterproof, is used. This type of paper mold has been used by the Concrete Ship Section of the Emergency Fleet Corporation to obtain samples of concrete used in the concrete ships and barges built by it.

*Method of Mixing Concrete.*—To determine the benefit to strength due to mixing of cement and water for a long period (15 to 30 minutes), and then adding aggregate to produce a concrete instead of the ordinary method of mixing cement, aggregate, and water together for one to two minutes, comparative tests of concrete by the two methods were made, using exactly the same materials and amount of water. The compressive strengths obtained were about the same, indicating that there is no advantage in long premixing of cement and water from the standpoint of strength.

*Tests of Diatomaceous Earth as a Blend and Admixture in Portland Cement.*—Tests made using diatomaceous earth or kieselguhr as a blending material or an admixture to Portland cement show that in general the strength of concrete and mortar made with the blended cement is weaker than that made of pure Portland cement. Absorption of concrete and mortar made with blended cement has been found to be greater.

*Tests of Old Storage Cement.*—During the progress of the war large stocks of cement were often shipped to various jobs at the beginning of the work and stored until needed. In some cases this storage period amounted to more than a year, and several such samples were submitted for test. The results of tests indicated reduction in strength for the storage cement, but this change was not marked for material which had been stored on the job for less than one year. One lot which had been in storage over two years gave the same strength in compression for 1:1½:3 concrete as was obtained for a 1:2:4 concrete made with the same brand of new cement. The old cement when gauged with a 5 per cent calcium-chloride solution showed an increase of about 30 per cent at seven days over the same cement gauged with ordinary mixing water.

*Inspection of Buildings and Other Structures.*—Assistance has been given two Government departments during the past year in connection with concrete structures under construction in cold weather. In one case, after partially stripping the forms from the A frame of a concrete dam, the concrete appeared only partially set and the quality of both cement and aggregates was questioned. Inspection showed the concrete not to have been frozen, but the hardening to have been retarded by low temperatures, and it was recommended that the mass be protected from possibility of freezing and allowed to stand. Tests showed the cement and aggregates to be of good quality and that with the usual cold-weather precautions good quality concrete would result. In the second case a concrete roof was poured just previous to a drop in temperature, with the result that the upper surface for a depth of one-half to 1 inch was frozen. Rather than tear out the injured section of roof it was recommended that a load test be applied after the usual period of curing. The results of this test proved that the frozen slab had the necessary structural strength, and removal was not necessary.

The marble floor of the Arlington Memorial Amphitheater has been developing rather extensive cracks, these being noticed before the completion of the floor in the spring of 1918. Several inspections were made and laboratory tests were made on the floor materials. The very rigid construction of the floor and the wide range of temperature to which it is subjected appear to be the chief causes of the cracking. A report embodying the results of the studies was submitted to the Arlington Memorial Amphitheater Commission.

Inspections have also been made of the ornamental concrete and stuccowork at Meridian Hill Park and East Potomac Park at the request of the Committee on Public Buildings and Grounds. These structures show only minor defects resulting from slight faults in design and are excellent examples of the architectural possibilities in surface-treated concrete.

*Miscellaneous Tests.*—Aside from the tests reported in the preceding paragraphs, numerous tests of a miscellaneous nature have been performed for the Government departments, as follows: Tests of sands, sea shells, gravels, and stones to determine their suitability for use as concrete aggregates; sieve analyses of sands, silica grits, silica washes, and granulated cork; transverse strength and absorption tests of brick; compressive strength of concrete cubes and cylinders; permeability tests of concrete and bituminous waterproofing felts.

### Tests of Cement for Governmental Purposes.

During the first part of the past year the testing of Portland cement for the different branches of the Government far exceeded the amounts ever tested during a similar period. As a result, the total amount sampled, tested, and shipped for the entire year largely exceeded that of any previous year. There were sampled 426,878 barrels. Of this amount 296,705 barrels were shipped, 35,000 barrels were withdrawn by the manufactures on account of unsatisfactory tests as determined by them before the Bureau made its tests, and 75,000 barrels were rejected by the Bureau on account of failure to meet the requirements of the specifications. The withdrawals and rejections also far exceeded those of previous years, but it was due entirely to unsatisfactory labor conditions at the plants. The manufacturers were constantly forced to replace skilled labor with new, which always tends to interfere with proper production.

### Soundness of Portland Cement.

In the course of the investigation of Portland cement which the Bureau has been conducting for years it has produced in its experimental plant a number of cements which were unsound according to the "boiling test." Neat, mortar, and concrete specimens were made of these cements, and they have been under observation for approximately five years. Depending upon whether the disintegration in the "boiling test" was very slight or very marked, the neat and mortar specimens showed expansion and cracking in from three months to one year. However, this expansion was not uniform throughout the specimen, but was always decidedly less on that surface exposed to the air during the first 24 hours' storage in the damp closet, the surface frequently not cracking at all, while the opposite side would show large cracks. This caused a bending of the specimen. The strength of the small specimens was usually very high at the early periods of testing.

The differences in the concrete specimens were very noticeable. These specimens, made for the determination of compressive strength and stored in the damp closet, do not show any cracking or marked loss of strength. The concrete specimens made for the determination of the coefficient of expansion show excessive expansion and disintegration when stored in the air of the laboratory. The latter is not manifested by cracking, but by crumbling under slight abrasion. Specimens made at the same time, but stored in water, are apparently sound, being free of cracks and very hard, but show very marked expansion, amounting to one-tenth of 1 per cent or more. Notwithstanding the apparent soundness of the concrete, when stored in the damp closet or in water the expansion, as shown only by actual measurement, shows this cement to be of questionable value, and in a manner justifies the use of the present "boiling test."

### Magnesia Content of Portland Cement.

Notwithstanding the fact that all the specifications for Portland cement in this country within the past few years have raised the allowable magnesia content of Portland cement to 5 per cent, there seems to be a desire to raise this amount still further. This matter is covered in Technologic Paper No. 102 of the Bureau, wherein the change in constitution and properties of Portland cement with a change in magnesia content of from 2 to 25 per cent was studied. Briefly, the conclusions were that there was no marked change until the amount exceeded approximately 7 per cent.

At the time the above-mentioned paper was issued, the concrete made from the cements in question had been under observation for about two and a half years. The majority of the specimens are now five years old. It is not the intention to break these and secure quantitative data before there are evidences of disintegration shown by the very high magnesia cement concrete. At the end of five years, however, all are apparently in excellent condition, without any signs of disintegration. Furthermore, it should be borne in mind that the chief fault of the high magnesia cements ($MgO$ exceeding 7 per cent) was largely that of very low strength at early periods. Disintegration was not a noticeable feature of the concretes at any period, though mortar-and-neat test pieces made from cements containing magnesia in excess of 10 per cent disintegrated in from one to three years.

### Magnesium Oxychloride (Sorel) Cements.

The development of tests for use in specifications covering the purchase of magnesia for use in magnesium-oxychloride cements has not progressed very satisfactorily. The principal difficulty is the different action of the cement in mixtures used in flooring or stucco from that when used with a standard reproducible aggregate or standard Ottawa sand. In practice one of the aggregates is a fibrous material, as asbestos or sawdust. On account of the manner in which these latter occur, it is practically impossible to secure similar materials (as to fineness, length of fiber, thickness of fiber, etc.) at different times. Therefore, it would seem to be very unsatisfactory to use these in a standard test. These cements, however, do require a fibrous aggregate to reduce the marked volume changes which occur in their setting and hardening. Consequently, standard sand does not seem to furnish an aggregate which gives results that can be correlated with those obtained from a fibrous aggregate or in general practice. Further work is being carried on along this line, however.

At the present time the Bureau is receiving samples from shipments received by a number of composition-flooring manufacturers. Test pieces are being made with these of both a flooring and standard sand mix to determine both the tensile and compressive strengths at different periods and the coefficient of expansion. At the same time the manufacturer is making particular note of the results he obtains in practice with these same shipments.

### Concrete Columns with Cast-Iron Cores.

The results of the investigation of the strengths of these columns are incorporated in Technologic Paper No. 122, now in press. Eighteen columns for tests were fabricated by L. J. Mensch, consulting engineer, under the Emperger system of reinforcing, in which cast-iron cores are used as the reinforcing material. The columns ranged in length from 6 to 14 feet and were 13 inches in diameter. The cast-iron cores were 6-inch hollow cylinders, three-fourths of an inch thick, and were placed concentric with the axes of columns. The total loads borne by these columns varied from a minimum of 858,000 pounds to a maximum of 1,041,000 pounds, or 6,700 and 8,160 pounds per square inch, respectively, on the basis of equivalent columns of solid concrete; that is, were about twice the usual strengths for such columns as ordinarily reinforced.

The cost of fabrication of this class of columns is considerably less than ordinary concrete construction to carry the same loads and approximately half that of a steel column of the same strength. The rather remarkable showing as regards strength and ease of fabrication suggests that this type of construction be studied by practical structural engineers with a view to a possible wider introduction in building practice.

## LIME, GYPSUM, ETC.

(The work of the section was somewhat interrupted by moving the laboratory from Pittsburgh to Washington. The delay incurred was magnified because it was accompanied by an almost complete change of personnel. The section is now established in its new quarters in Washington and is better equipped than it has ever been.)

### Cooperation with Lime Manufacturers.

All of the manufacturing interests with which this section deals have accorded official recognition of the work. The Lime Association, the Gypsum Industries Association, and the Sand-Lime Brick Association have all appointed, within the past year, special committees on cooperation with the Bureau of Standards.

At its last annual meeting the Sand-Lime Brick Association passed a commendatory resolution, which has been engrossed and presented to the Bureau.

The section has continued its active cooperation with the American Society for Testing Materials, and during the past year its members have accepted the chairmanships of the subcommittees on specifications for structural lime, on methods for measuring plasticity, and on methods of test for gypsum products.

On January 6, 1919, at the instigation of this section, there was formed an interdepartmental conference on chemical lime. This conference is composed of 15 members, 4 of whom represent the Bureau of Standards.

### Compressive Strength of Cement-Lime Mortars.

The extended use of mixtures of lime and cement as mortar for laying brick has brought about a demand for information as to the way in which the properties of such mortars vary with their composition. It was found that the strength of such mortars is proportional to the quantity of cement contained in them and to the density of the mortar. This latter factor is affected by the quantity of lime added. The detailed results were published in the Journal of the American Ceramic Society for January, 1919.

### Effect of Addition of Hydrated Lime Upon Properties of Concrete.

This work, which was started in 1915, was continued during the past year by conducting experiments under field conditions at Cedar Hollow, Pa. Concrete with and without lime was mixed in the ordinary type of concrete mixer and allowed to flow down a chute 100 feet long. The effect of the lime upon the time required to flow down the chute and upon the other properties of the concrete was determined. This work is conducted under the guidance of a special advisory committee appointed by the Bureau for the purpose. The results of the Cedar Hollow experiments were presented to this committee on June 24, 1919. The committee decided that the information at hand is not sufficiently complete to warrant the publishing of anything at present. A program for the present year's work was mapped out at that meeting.

### Carson Plumb Bob Test.

A method of test, wherein a plumb bob was used to determine the properties of lime plaster, was devised by William E. Carson. At the request of the subcommittee on structural lime of the American Society for Testing Materials, the Bureau conducted an investigation to determine the practicability of this test. A favorable report was presented to the committee, but no action has as yet been taken in the matter.

### Possible Causes of Unsoundness of Lime Plasters.

The "popping" of lime plaster is very unusual, but when it does occur, it is sufficiently serious to warrant an investigation as to its cause. Apparently little particles of the plaster expand enough to push themselves clear out of the wall, leaving "pin holes" in the plaster. This occurs from six months to two years after the wall has been plastered. Our investigation includes making specimens of plaster to which has been added known quantities of suspected ingredients, storing them in the air, and watching them for signs of popping. While some of the samples have failed already, the specimens are not yet old enough to be sure that those which are now sound will remain so.

### Measurement of Plasticity.

Plasticity—ease of spreading—is the property which virtually controls the selling price of hydrated lime; yet there is no generally accepted method for measuring this property. For many years the Bureau has been designing instruments to measure plasticity, experimenting with them, noting their defects, and redesigning them. This year one instrument was designed in February and put into operation in May. To date, it has not given entire satisfaction. Another instrument, of much more elaborate and complicated type, which was designed in 1917, has just been completed. The principle upon which these instruments operate has gradually been evolved until reasonable assurance is felt that it is correct. The changes made are rather in details of design and operation.

The method of measuring plasticity developed for lime should be equally applicable to gypsum and all wall plasters.

### Standard Sand.

For almost every purpose lime is mixed with sand before it is used. Obviously laboratory tests should, therefore, be made not on the lime itself, but on sanded mortars made from the lime. For this purpose, it is necessary to establish arbitrarily a standard sand in order that every laboratory in the country using the same sand may obtain comparable results. In cooperation with the American Society for Testing Materials, the Bureau has undertaken to write the specifications for this sand. The task is to find a sand which is satisfactory for the purpose and which can be obtained uniform in quality. The work has not yet been completed.

For the reasons given above a standard sand is also essential for tests of gypsum. Probably the same sand can be used with both materials.

### Reinforced Gypsum.

Shortly before the entrance of the United States into the war the application of reinforced gypsum to roof construction was developed by one of the largest manufacturers of gypsum in the United States. A considerable amount of scientific work was done which afforded a sound basis for the design. With these data as a basis, a member of the Bureau of Standards' staff has participated actively in the formulation of standards for design of reinforced gypsum. These standards have been accepted as a tentative report to the American Society for Testing Materials and are being printed in the proceedings for 1919. During the war many thousand square feet of reinforced gypsum roof designed by these standards were used in Government buildings.

### Factors Influencing Time of Set of Gypsum.

The standard method for measuring the time of set of calcined gypsum has not yet come into general use; it is still subject to modifications. This study was undertaken to determine the effect of certain changes in the method of manipulation. It was found that the addition of excess water to the gypsum makes it set more slowly; that if the gypsum and water are mixed vigorously the set will be hastened; that the temperature of the water has nothing to do with the time of set. The detailed results of this work were published in the Journal of the American Ceramic Society for August, 1918.

### Increasing the Strength of Gypsum and Making it Waterproof.

Gypsum is now used for the manufacture of hollow tile and of reinforced roofs. Its inability to withstand the action of the weather limits its field of application. After a number of experiments a method of manufacture was evolved whereby gypsum tile may be produced having, when compared with ordinary tile, three times the strength and three times the ability to resist erosion by water. These results, but no details of the method, have been presented to the Gypsum Industries Association with the hope that they will take sufficient interest in the subject to put it into use.

### Measurement of Properties of Commercial Gypsums.

The tentative standard methods of test for calcined gypsum as adopted by the American Society for Testing Materials in 1919 have not been used sufficiently to determine the numerical results which they will give. For example, it is not known what the tensile strength of a good gypsum should be, because so few samples have ever been tested by the standard method. For this reason the Bureau has undertaken to test about 100 samples of commercial products and to compile the results in such a way that the proper numerical values can be inserted in the specifications for these products. The tests include chemical analysis, water-carrying capacity, time of set, fineness, tensile strength, compressive strength, and yield. This work is about 20 per cent completed.

### Effect of Gradation of Sand on Properties of Sand-Lime Brick.

The properties of a sand-lime brick depend very largely upon the quality of the sand of which it is made. Whether this sand is fine, course, or graded is very important. The sand used in these experiments was sifted into three sizes—fine, coarse, and medium. These were then mixed in predetermined proportions, and bricks were made of them. It was found that a mixture of 40 per cent fine sand and with 60 per cent coarse and no medium gave the strongest bricks. The detailed results were published in the proceedings of the Sand-Lime Brick Association for 1919.

### Factors Influencing the Bond Between Mortar and Sand-Lime Brick.

If a chain is no stronger than its weakest link, then a pier built of good bricks and good mortar may not give satisfaction because of poor bond between the mortar and the brick. Tests of brick piers published in Bureau of Standards Technologic Paper No. 111 show that the strength of the pier will seldom exceed 30 per cent of the strength of the brick, even when the best mortar is used. Our experiments have shown that the bond between mortar and sand-lime brick is affected by two factors. One of these is the laitance. When the green brick is formed in the press, the water in the raw mix comes to the surface, carrying with it soluble salts, which are deposited as a scum. This scum, or laitance, gets between the mortar and the brick, and interferes with the adhesion. The other factor is the size, number, and shape of the pores on the surface of the brick. Sometimes the sides of these pores are bent over to form a key to which the mortar adheres strongly. Both of these factors are subject to control by varying the consistency of the raw mix and the molding pressure. An article on this subject is now in course of preparation

### Effect of Duration of Hardening on Properties of Sand-Lime Brick.

The laboratory experiments on this subject, the results of which were published in the Proceedings of the Sand-Lime Brick Association for 1918, showed that nothing is to be gained by curing the brick for more than four hours. This curing is done by exposing the brick to high-pressure steam for from 7 to 12 hours. Such a marked reduction in the time would, therefore, result in an enormous saving of fuel, to say nothing of the additional output possible with the same equipment and overhead. The manufacturers took up the idea with avidity and volunteered to cure brick for different periods of time and send them to the Bureau to be tested. This was to make sure that the results obtained in the laboratory could be duplicated on a large scale. Owing to the unusual business conditions some of the manufacturers have not yet been able to make the samples for the Bureau. The work is at present about 40 per cent completed.

### Routine and Miscellaneous Work.

A lime manufacturer was receiving complaints that his hydrate was not plastic. A week spent at his plant studying the conditions showed that the trouble was due to overburning the lime; and recommendations were made accordingly. Samples of this hydrate received at frequent intervals since then indicate that the trouble has been overcome.

At the request of the Industrial Cooperation Service, the manufacture of sorel cement was investigated. This cement was being used for drain boards, table tops, etc., and the sawdust added to it as a filler was proving objectionable because of discoloration. After numerous tests the Bureau learned how to make these articles, using sand instead of sawdust, without impairing the peculiar characteristics of the sorel-cement surface.

An investigation of the waste shells from the pearl-button industry indicated that, while they could be calcined to produce a good quality of lime, it would probably be better economy to market them as ground limestone.

The routine testing for Government purchase has been negligible, consisting of one sample of hydrated lime for the Supervising Architect and five samples of quicklime for the Panama Canal.

Before the armistice a great deal of time was spent in active cooperation with the Quartermaster's Department, the gas-warfare service, the forest products laboratories, and other Government agencies in enabling them to obtain the quality of lime best suited to their needs. Meetings of the War Industries Board were attended, wherein were discussed proposed specifications for magnesite stucco and for gypsum plaster board.

## RUBBER.

(Investigation and testing of rubber and rubber goods to determine the physical and chemical properties and the development of specifications.)

### Rubber Analysis.

On account of certain routine work on the analysis of rubber goods it became necessary to find methods for the determination of constituents not before considered. Glue is one of these constituents. Its amount can be ascertained with sufficient accuracy by determining nitrogen by the Kjeldahl method. A reliable qualitative test for glue was also devised.

Rubber soles for shoes contain cotton and other organic fillers. It is hoped that a new method for the determination of the amounts of these constituents, which is still under investigation, will soon be perfected.

Considerable time has been spent during the last six months on a new method for the determination of mineral fillers in rubber goods. Even in its present incomplete state the method gives more accurate results than can be obtained by the usual combustion method, because most of the fillers used are unchanged as the rubber goes into solution.

Very interesting results were obtained by the use of mixed solvents in extracting rubber. A paper on the subject was prepared for publication.

It is gratifying that the Bureau's methods of analyzing and testing rubber goods are generally recognized as accurate and reliable. As an illustration of this, the specifications for solid and pneumatic tires issued by the Motor Transport Corps require that these methods be employed.

### Balloon Fabrics.

Many samples of balloon fabrics received for permeability and aging test were analyzed.

### Rubber Tires.

In the year beginning March, 1918, over 500 samples of solid truck tires, representing about 250,000 tires, valued at about $20,000,000, were analyzed for the War Department. Army inspectors at the various plants performed most of the routine physical tests, but samples were sent regularly to the Bureau as a means of checking their results. A large part of this work was done during the period covered by this report.

The preparation of specifications for pneumatic tires and inner tubes was, for several reasons, a very difficult task, in which this Bureau cooperated. The specifications, which were issued in October, 1918, were based on an elaborate series of physical tests and chemical analyses made at the Bureau. A large number of tires and tubes, representing the products of numerous manufacturers, were used for this work. The number of samples it was proposed to send for analysis was so great that immediate arrangements had to be made for a larger force of chemists and more commodious quarters. The Bureau must thank the Municipal University of Akron, Ohio, for the use of the space and facilities necessary. This was particularly fortunate, because Akron is the greatest center for the manufacture of tires.

Approval of tires and inner tubes for purchase by the Motor Transport Corps was based on the results of tests and analyses made by the Bureau of Standards in accordance with their specifications.

Owing to the armistice, the branch laboratory in Akron was never utilized to its full capacity, and it was abandoned in June, 1919.

### Assistance Rendered Manufacturer of Solid Rubber Tires.

Assistance was rendered a manufacturer of solid-rubber tires in improving the quality of the compounds used, and in improving the bond or adhesion between the tread stock and the hard-rubber base. Various formulas, based on a three-hour cure, were suggested by the chemical division and made up, cured, and tested in the physical laboratory. A solid tire which met all the requirements was developed. This involved a physical and chemical study of the nature of the bond between hard and soft rubber. Some interesting data on this subject were obtained.

### Power Loss in Automobile Tires.

An investigation will be undertaken to determine the power loss or energy absorbed by different types of automobile tires, and to study the effect of "tire fillers" on the life of pneumatic tires and the power absorbed as compared with the power absorbed when inflated with air. Special equipment in the way of electrical absorption dynamometers is being installed for this work.

### Rubber Packings.

These are needed in the recoil cylinders of field guns. Work was started over a year ago, since which time samples submitted by manufacturers have been tested. A recent undertaking was the development of an oilproof packing in cooperation with a concern manufacturing air brakes. The Bureau's rubber plant is being used in connection with the compounding and vulcanization of experimental mixtures for trial packings.

### Hospital Supplies.

Many samples of rubber sheeting, tubing, hot-water bottles, air cushions, surgeons' gloves, etc., were tested and analyzed for the Field Medical Supply Depot. The Bureau has been requested to prepare standard specifications for the purchase of these materials.

### Tests of Fire Hose for Government Departments.

During the past year the Bureau continued its cooperation with Government departments in testing fire hose. All fire hose used by the local fire department is purchased on the basis of tests conducted at the Bureau. Tests of this sort were also made for the Panama Canal and for the General Engineer Depot of the Army.

### Rubber Jar Rings for Canning.

A very important item in connection with the matter of food conservation is the subject of jar rings. The Bureau was requested by the States' Relations Service of the Department of Agriculture to cooperate in the production of standard specifications for jar rings in order to establish a standard of quality for use by the public and to eliminate the many inferior brands of rings that had been the cause of extravagant waste as a result of food imperfectly preserved.

The Bureau's method of procedure was to imvestigate the physical and chemical properties of the various grades of jar rings on the market and to compare the results obtained with the known behavior of the rings in service. It was found that of the many different grades of commercial rings obtainable those having certain physical properties that are easily measurable may be depended upon to give satisfactory results. Specifications written by the Bureau included a series of simple tests and measurements, and the specifications are now published by the Department of Agriculture and recommended for use by the public.

### Miscellaneous Rubber Goods.

Rubber hose of different kinds, such as are used for steam, water, air, etc., together with miscellaneous rubber goods, such as belting, valves, and packings, commonly classed as "mechanical rubber goods," were investigated by the Bureau at the request of the War Department. The object was to develop standard specifications for materials of this sort to be used as a basis of award in the purchase of supplies for military purposes.

The methods followed in investigating and correlating the physical and chemical properties of the various kinds of rubber goods had, for the most part, been previously developed at the Bureau in connection with similar work for other Government departments. In addition to chemical analyses to determine the percentage of rubber present and its quality physical tests were made to measure the quality and strength of fabric and the strength, stretch, and elasticity of the rubber as an indication of the correctness of vulcanization. A study and comparison was made of various articles in each of the numerous classes of materials as a means of judging the excellence of fabrication. When practicable, the materials were subjected to conditions approximating those of service, and in some cases accelerated aging tests were conducted as a means of estimating the relative life of the rubber compounds used.

As a result of the laboratory investigations referred to and numerous conferences with manufacturers and representatives of the War Department standard specifications have been adopted for practically all miscellaneous rubber goods used for military purposes.

During the past year a total of 994 miscellaneous samples were tested physically and in many cases subjected to chemical analyses. The following items are representative of the materials handled: Rubber hose (fire, water, air, air-brake, suction, steam, etc.), 98; rubber-covered wire, 110; packing (asbestos and rubber, square spiral steam, plain sheet, sheet-wire insertion, asbestos sheeting, etc.), 102; jar rings, 82; dredging sleeves, 55; asbestos gaskets, 34; automobile, motorcycle, and bicycle pneumatic tires, 128; inner tubes, 50; solid tires, 44; rubber bands, 11; gas-mask check valves and nose pads, 42.

The majority of these tests were made at the request of the Motor Transport Corps, the General Engineer Depot, the Chemical Warfare Service, the Signal Corps, Medical Supply Depot, the Panama Canal, and the General Supply Committee in connection with contracts and to secure experimental data for use in the preparation of specifications.

## Future Work in Rubber.

An interesting program of investigations on problems relating to rubber was mapped out. It is hoped that satisfactory progress can be made during the next year.

The increased laboratary space provided for the experimental rubber plant in the new industrial building will make it possible to handle a greater volume of tests and to perform investigations on a larger and more comprehensive scale than in the past. In the new laboratory the vulcanizer will be equipped with automatic temperature and time controllers and recording thermometers, which will eliminate certain errors in temperature regulation due to the use of steam-pressure reducing valves.

## LEATHER.

(Investigation and testing of leather and leather goods to determine the physical and chemical properties and the relative durability of different kinds of leather upon which to base standards of quality.)

After the signing of the armistice the requirements of the War Department for leather goods were greatly decreased, and hence the amount of routing testing work was considerably reduced. This fact has allowed the personnel of the leather laboratories to devote nearly their whole time to investigation and research during the greater part of the fiscal year. The results of many individual investigations have been obtained and several new problems have been started. The general plan followed has been to correlate, in so far as possible, the tensile strength, stretch, buckle strength, water absorption, and wear, with the chemical composition, of the particular leather involved. Owing to the nature of the material, the methods for the analysis of leather are almost entirely empirical. It is nearly impossible to check the accuracy of a given procedure by analyzing samples of leather prepared so as to contain a known percentage of a given constituent. For this reason the methods adopted by the American Leather Chemists' Association are followed closely by this Bureau. The work during the fiscal year may be divided into the following parts: Sole leather, harness and strap leather, upper leather, miscellaneous, development of specifications, and routine testing.

### Sole Leather.

On pages 154 and 155 of the last annual report mention is made of six different problems relative to the wear of sole leather which it was proposed to investigate. Progress has been made on all of these. Preliminary results have been obtained in the investigation of the comparative wear of the belting tannage with the sole tannage, and also in the investigation to determine the effects of oils and greases on the wearing quality of sole leather, but further tests are planned before definite conclusions are drawn. Technologic Paper No. 138 contains the results of the first of a series of tests to determine the effects of glucose as well as Epsom salts on the wearing quality of sole leather. The leathers used in this test were (1) a lone-time tannage with a minimum addition of glucose and salts, (2) a leather tanned to the belting stage and then filled with the maximum amount of extract by drumming, (3) a leather tanned to the belting stage and then filled with a large amount of glucose, and (4) a leather well tanned and moderately filled with glucose and salts. All were oak-tanned leathers. All the bends were cut into soles according to a definite plan, and each individual test consisted of comparing a sole filled with glucose and salts with one with no appreciable amounts of these materials added. Both soles in any test were cut from the same relative location on the hide. Service tests were made on soldiers at Camp Meade, Md. The laboratory work consisted chiefly of abrasion tests on the laboratory wearing machine, complete chemical analyses of the new and worn soles, and water-absorption tests. The success of the work was made possible through the hearty cooperation of the War Department, the Tanners' Council, and the American Leather Research Laboratory. The second test of this series has been started, the leather used in this case being hemlock without the addition of glucose and salts, hemlock with the addition of about 10 per cent of these materials, and a long-time, oak-tanned leather. The hemlock leather was made from dry hides. The amount of water-soluble materials in the two hemlock leathers differed on an average about 11 per cent on account of the difference in glucose and salts present in each of the leathers. This fact will allow information to be obtained regarding the comparative durability of low and high water-soluble leathers. A comparison of the relative durability of oak and hemlock tannages will also be obtained from this test. A comparison of the durability of vegetable and mineral tannages will be secured from the following tests, which are in progress: (1) Oak as compared with chrome tannage from different hides, (2) oak as compared with chrome tanned from the same hide, and (3) oak as compared with alum-tanned leather from different hides. Actual service tests have also been started to determine the effect of light and heavy rolling on the durability of leather from the same hides.

Several series of tests on the wearing machine to show the relative durability of sole leather from different parts of the hide have been completed, and, together with a description of the machine and the methods of testing, will be published as a technologic paper of the Bureau.

### Harness and Strap Leather.

Investigations of harness and strap leathers were started in order to learn the effects of different amounts and kinds of stuffing, and of acidity upon the strength of the leather, and upon the rate of deterioration during storage. Owing to the long life of these leathers, service tests seemed impracticable.

An attempt was made to correlate the physical properties of different harness leathers with the stuffing content of the leathers. Three distinct tests were made with three different hides. One hide was tanned as regular russet harness leather, and had one side stuffed with an average of 23 per cent grease and the other with an average of about 11 per cent. Another hide had one side given a light tannage and the other side a heavy tannage, and then both were finished as regular russet harness leather. Still another hide was tanned as regular russet harness leather, and had one side stuffed with a mixture of 50 per cent cod oil and 50 per cent tallow, and the other side stuffed with a mixture of 50 per cent mineral oil and 50 per cent tallow. These tests were conducted to show the effects of different amounts of stuffing contents, of the variation in stuffing content over the hide, of different degrees of tannage, and of animal and mineral oils on such physical properties as the tensile strength, buckle strength, and stretch. The results of these tests will be published within a short time.

### Upper Leather.

*Water Resistance.*—Several tests were made to determine the comparative resistance to water of chrome-retanned and bark-tanned upper leather used in making Army shoes. Service tests showed that the chrome-retanned leather resisted water better than bark-tanned with the particular leathers tested. Laboratory tests showed that if properly stuffed chrome-retanned and bark-tanned upper leathers are equally resistant to water. In both cases the resistance seemed to depend entirely upon the amount of stuffing content up to the point where the pores of the leather were completely filled.

*Resistance to Fermenting Animal Mixtures.*—The relative resistance of chrome-tanned and bark-tanned upper leathers to fermenting mixtures of animal products was also investigated to determine the relative fitness of the two leathers for use in trench shoes. The data indicated that the chrome-retanned leather was much more resistant than the bark-tanned.

### Miscellaneous.

*Leather Packings.*—A heat-resisting leather is needed for packing in the recoil cylinders of large guns. A number of samples furnished by the Ordnance Department and others, tanned at the Bureau, were tested by heating in mineral oil at temperatures up to 225° C. for varying lengths of time. The effects of using different stuffing mixtures were also determined.

*Waterproofing Leather.*—The efficiency of different experimental and commercial preparations for waterproofing leather was investigated.

*Artificial Leather.*—Increased use of so-called artificial leathers and the absence of satisfactory tests caused an investigation to be started and to develop standard methods of testing to determine the quality and durability of these materials.

### Development of Specifications.

During the fiscal year representatives of the Bureau have assisted the War Department, Panama Canal, and the General Supply Committee in developing specifications for leather. The work consisted of acting in an advisory capacity, as well as making extensive laboratory determinations for the establishing of limits for certain constituents and physical properties of the various leathers. Much progress is expected during the coming year in developing standard specifications for leather.

### Routine Testing.

As usual, a part of the time during the year was devoted to routine testing work for the various Government departments in making such tests as tensile strength, buckle strength, and chemical analyses. The materials tested included harness leather, strap leather, upper leather, sole leather, belting leather, lace leather, horsehide for baseball covers, packing leather, and waterproofing compounds.

### Experimental Tannery.

Arrangements have been proposed and partially perfected for installing a small experimental tannery at the Bureau to be operated in cooperation with the Tanners' Council. Preliminary plans for a complete installation have been drawn up, and in the event of a successful termination of the plans as contemplated, the Bureau will be in a position to render valuable assistance to the leather industry in carrying out exhaustive investigations for the solution of important problems relating to the tanning and leather manufacturing industries, especially the determination of the properties upon which the quality of leather depends.

### Laboratory Facilities.

The Bureau's new industrial building, which has just been completed, provides ample laboratory space for extensive research and testing in accordance with the program that has been planned, and will permit of more efficient cooperation with the various Government departments to meet their increasing demands for such work.

Additional laboratory equipment is being installed, consisting of testing machines, machines for cutting shoe soles and skiving leather, and a complete outfit for shoe-repair work.

## TEXTILES.

(Investigation and testing of textiles to determine their physical and chemical properties. Development of new materials. Preparation of specifications.)

Although considerable work has been done for the military organizations, such as the War and Navy Departments, since the signing of the armistice, both directly and in a cooperative capacity, there has, of course, been a gradual decrease in the rendering of such services, while, on the other hand, the industries of the country have called upon the Bureau for tests, information, and cooperation even to a greater extent than in previous times.

### Identification of Fibers.

The kind of service which a fabric, yarn, or material will render can always be estimated, provided an accurate knowledge of the substance is at hand. The scientific examination of such materials divides itself into three classes—physical, chemical, and microscopic—with accuracy as a chief consideration in respect to the last named. When the first two of these methods of examination do not give the results expected, the microscopic, in general, proves satisfactory.

### German-Uniform Fabrics.

One of the chief uses of the microscopic method of identification was in the analysis of the fiber content of German war textiles. Airplane fabrics and uniform fabrics were examined carefully to discover substitute materials. A large shipment of uniform fabrics taken from German officers and soldiers was received from the Purchase, Storage, and Traffic Division of the War Department, to be examined carefully, tested, and studied for any useful information which might be derived thereby. From the specimens submitted it was found that the materials or fabrics used in the uniforms were much lighter in weight than those used in making woolen uniforms for American soldiers. It is thought that by a change in constructon more service could have been obtained from the German fabrics.

### Ramie Felts.

Examination by the microscope and photomicrographic prints of samples of a so-called ramie felt showed that 25 per cent of the fiber content was wool taken from the back of a sheep. Further examination showed that the ramie fiber had been treated to increase its felting qualities, giving it a very fine wavy outline, and putting it in the class of fibers known as vegetable wools. Only a slight trace of cotton fiber was found.

### Airplane and Balloon Fabrics.

Prints obtained from photomicrographic plates of airplane fabrics showed the penetration of dopes and pigments into the interstices of the cloth, the amount of dope and pigmented protective covering used, and the kind of bond which existed between them. The study was carried out not only on American fabrics but also on fabrics taken from wrecked or captured German airplanes.

Balloon fabrics, as well as the bonds and fastening of rubber seams of various constructions, were studied by this means with the same object as the study of airplane fabrics.

### Sealskins.

In the process of determining the effect of two dyers' processes ot dyeing on samples of sealskins taken from the same killing the photomicrographic examination was most helpful. Two skins, considered to be fairly representative specimens of the product of dyeing this type of fur, were submitted. At the request of the American manufacturer tests were made to compare his method of dyeing with that of a foreign dyer, the purpose being to discover the difference between the two methods. The results showed that the American method was superior. Both skins were dyed with the same dyestuff, but it was very clearly shown that, although the chemical study indicated only a wide variation in the amount of metal used as mordants, the microscopic study presented a number of distinctions which existed between the skins.

### Miscellaneous Identifications.

A large number of samples of rope, twine, cord, thread, linen, flags, and other textiles were examined for the General Supply Committee.

### Oakum Specifications.

The Bureau was called upon to assist in the drawing up of standard specifications for oakum for the caulking of vessels, the need for which had been greatly increased by the rapid growth of shipbuilding in this country. The War Industries Board, together with the Shipping Board, found that specifications were absolutely necessary to cover this class of material. A conference was arranged with the above-mentioned boards, together with representatives of the leading oakum manufacturers in this country.

The chief points of consideration were: (1) What constitutes a good oakum for caulking? (2) What grades of oakum should be allowed in oakum? (3) What should be the allowable per cent of tar in the product? (4) What fibers should be allowed in the different grades of oakum?

As a result of this conference, a set of specifications was produced to be used for Government purchases, and also by individual corporations. The Bureau was selected to act as referee in the event of a dispute as to the grade and percentage of ingredients of oakum, acting only in an advisory capacity.

### Chemical Retting of Flax.

A great many processes were investigated as a result of the Nationwide desire for improved methods of manufacturing. The flax industry was among the more prominent of these. It is claimed that by a chemical process the degumming and retting of flax is greatly simplified and expedited, which would result in greatly increased activity of this industry in this country. The new treatment is said to dissolve the gum from the flax straw in less than one hour, leaving fibers similar in appearance to flax obtained by processes which require the submersion of the straw in water for a period of from 15 to 25 days, or in dewy meadows for a period of time from 5 to 8 weeks, subject to atmospheric conditions. This new process is under investigation by the Bureau, but as much time is required to complete the necessary experiments a conference was arranged at this Bureau to obtain all possible information on the subject and to see what could be done to aid the situation. Representatives of Government departments interested in the subject were present and had the opportunity of witnessing a few demonstrations of the chemical process of retting. Whether these fibers differ essentially from water or dew retted fibers, and also the advantages derived from chemical retting, remains to be determined.

### Cotton Goods.

The chemical work done on cotton goods intended for uniforms consisted in determining the nature of the dye and testing the fastness of the color. This was carried out in accordance with methods agreed upon by officials of the War Department interested in the subject.

### Waterproofed Canvas.

Waterproofed canvas for military use must be not only thoroughly waterproof, but also resistant to mildew, free from objectionable odor or poisonous material, permanently pliable in cold weather and after prolonged exposure to sunlight. In addition to determining the nature of the waterproofing material used on many samples of tarpaulin, etc., two strenuous tests were used to imitate the effect of beating rain and of lying on wet ground. Tests were also made to learn the resistance to mildew, to cold and heat, and to sunlight.

Much of the resistance to water depends on the closeness of the weave of the cloth. When waterproofing materials were received for test they were applied to suitable canvas which showed no "pinholes" when held up against a bright light.

These waterproofing materials and commercially waterproofed tarpaulins differed widely among themselves as regards their behavior in the different tests. Analyses showed that they also differed widely in composition.

The examination of English, French, and German fabrics obtained through the War Department showed that few of them were as good as the average American canvas.

### Woolen Goods.

Woolen cloth for uniforms, overcoats, shirts, and blankets was tested for fastness of color, nature of the dye, and for the amount of cotton present. A large number of felt samples were analyzed at the request of the War Department.

### Commercial Dyeing Practice.

The fastness of color of cotton goods dyed in the piece depends to a considerable extent upon the skill and care of the dyer and upon the way in which the mechanical operations are performed. In cooperation with the Inspection Division, Cotton-Goods Branch, of the Quartermaster General's Office, samples from representative mills were frequently tested. This led to the recommendation of certain processes and the correction of the defects in the products of contractors who were producing faulty material.

Deficiencies in fastness of color were in many cases due to faulty mechanical processes, and not to dyes of poor quality.

### American Dyes.

At the request of the Quartermaster General and the War Industries Board a collection was made of all the available colors for dyeing the olive-drab shade on cotton and wool. From these strips of cloth were dyed by following closely on a laboratory scale the directions of the manufacturers. These dyeings were subjected to the usual tests to show the effect of sunlight, of dye-fading electric lamps, of washing and rubbing, of acid, etc. These test samples, more than 4,000 in number, were mounted on cards. They were much used in conferences with representatives of the War Department.

### Dye Making.

A great deal of time was devoted to the preparation of about 30 carefully purified dyes. This was done in connection with the projected development of a comprehensive method for the identification and analysis of dyes by spectroscopic measurements. Commercial dyes can not be used to obtain the fundamental data, because they are rarely simple, pure substances, but generally contain colored organic impurities. Different salts of metals are also frequently admixed. The optical properties of solutions of these dyes are now being studied by the Bureau.

### Mordants.

The bichromate used for mordanting wool colors was becoming scarce toward the end of the war, and experiments were made to ascertain whether it was feasible to use other mordants. It was found, however, that bichromate is superior to other readily available materials for this purpose.

### Mercerization.

The mercerized yarns produced by various mills differed greatly. This led to a long series of experiments in order to learn the effect of certain changes in the customary process of mercerizing on the physical properties of the yarns.

### Flax Packing.

Many samples of braided flax packing, impregnated with tallow, were examined. The grease content and its nature and the kind of fiber used were determined. Some of the packings contained cheaper fibers than flax, and the lubricant contained paraffin or other cheap materials.

### Sizing.

A great deal of time was spent during the past few months in analyzing and studying sizing compounds for use on cotton yarns. Some of these are manifestly far superior to others. This work was preliminary to practical studies in the Bureau's cotton mill.

### Camouflage.

Fabrics colored with different dyes may appear alike to the unaided eye when in the sunlight. In artificial light, or when viewed through a colored glass or celluloid screen, they may appear as unlike as red and green.

Samples of fabric dyed in this way and appropriately colored screens were prepared in cooperation with another section of the Bureau. Such fabrics as these dyed green and laid on grass can be used to convey secret signals to friendly aviators provided with suitable color screens, while to the unaided eye they will be invisible even at short distances.

### Routine Testing.

A large variety of commercial grades and kinds of fabrics, twine, thread, yarn, waste, packing, and loose fibers amounting to over 4,000 in number were tested. Of this number a fair proportion was received from the General Supply Committee and other Government departments.

### Airplane Fabrics.

Special studies were made of the standard airplane fabrics already in use, to improve their serviceability and reliability. After a study of the stresses of flight and stress distributions new fabrics were designed and manufactured. As airplanes became larger and heavier it was necessary to cover the wing with a stronger fabric, and after the study of the stress distribution a change in the construction was recommended and applied. Since the filling carried the larger part of the load when the fabric was applied to the wing in the logical manner—that is, with the warp ends running from the leading to the trailing edges of the wing—little warp was used, thus making the fabric lighter, while capable of doing the same work.

### Tautness.

As a result of the study of the behavior of wing fabrics under flight, a tautness meter was designed at this Bureau to investigate uniform methods of application and treatment in securing maximum life of a fabric after it had been placed on the wing. Under the present methods of application of the fabric to a wing, few tests have been made to find the proper initial tension of the undoped fabric, the elasticity of the dopes to obtain the best possible permanency of tautness in the wing fabrics, and their method of application, and no information has been compiled which states accurately when and why a wing fabric should be redoped and replaced.

Numerous readings were taken on wing coverings of planes already in service at McCook Field, Dayton, Ohio. It was plainly shown, as a result of these tests, that the observation of the tautness can be interrupted to show the effect of humidity and temperature on the life of the fabric. A report on this subject entitled, "The Preliminary Report on theMcGowan Tautness Meter, and a Study of the Tautness of Airplane-Wing Fabrics and Dopes," was compiled and distributed to interested military organizations.

### Penetration of Dope Correlated with Tear Resistance.

Samples of linen and cotton grade A airplane fabrics covered with different amounts of dope, applied by various methods in order to vary the amount of penetration of dope on the fabric, were received for test at this Bureau from the commanding officer of the Wilbur Wright Field. The test results showed many interesting facts, and the conclusions proved of much value.

### Balloon Fabrics.

After developing a standard balloon cloth, an investigation was started in cooperation with the Bureau of Construction and Repair, Navy Department, to increase the life and give better permeability. A number of cloths of various thread counts and weights per square yard have been made up accordingly and are now ready for tests.

### Satins.

In the determination of the wearing qualities of clothing a number of specimens of satins were submitted and tested on an abrasion machine recently designed and constructed at this Bureau. Although the machine itself is in its experimental stage, the results and conclusions derived are very interesting and promising.

### Banana-Plant Fiber.

At the request of the interests concerned, a series of tests were made on the suitability of fibers taken from the stalk of a banana plant as packing for journal boxes. A quantity of the fiber was obtained and tested both in the laboratory and in the journal boxes of railroad and street cars. Satisfactory service was obtained from the fiber as packing for street cars, but it did not prove as good as the wool waste now in use for packing boxes for railroad use. In both experiments one side of the car was packed with banana fiber and the opposite side with commercial wool waste.

### Tests of Baseballs.

At the request of the Purchase, Storage, and Traffic Division of the War Department a number of new tests were made on representative samples of baseballs, a large number of which were to be purchased for recreational purposes overseas. A detailed and comprehensive report was compiled and submitted. The method of manufacture, construction, composition, resilience, endurance under wear, and other properties of each baseball were noted and recorded, giving the purchaser some useful information from which to make a logical award for the purchase of the same.

### Experimental Textile-Manufacturing Equipment.

The textile manufacturing equipment of the Bureau consists of three units—a small felting unit, by which samples of felts are prepared for experimental purposes, made in such a way and of such materials as may be desired; a complete layout of full-sized cotton machinery and apparatus to make fabrics and yarns within wide limits; and a complete outfit of both full-sized and diminutive woolen machines.

These machines and the necessary accessories are of the latest improved construction and are equipped with the accurate adjustments necessary for the work intended. The reasons for the installation of this equipment are quite numerous. One of the fundamental purposes of the equipment was to aid in supplying the manufacturer of military fabrics with exact specifications of the fabrics then being produced. Those engaged in textile-research work were without exact knowledge of the physical properties of such materials, owing to their inability to obtain the necessary variety of fabrics. The present specifications are based on tests, such as the tensile strength, the weight per unit area, and a few other properties not used universally in all specifications, whereas the requirements pertain more to such qualities as those of heat retention and resistance to wear. The making of a sample fabric in a commercial mill seriously retards production because of the large amount of attendant waste of time and material necessary to operate the machinery properly, with no assurance that the sample produced will give the desired results.

It is certain that it would have been very profitable to have had such equipment at the beginning of the war before the Government had issued contracts for textile fabrics and yarns. To-day the value of such a laboratory is realized when it is considered that the products of the textile industry have never been scientifically investigated. Keen competition is to be looked for in the immediate future. It would appear of essential advantage to the American manufacturer of textiles to know more exactly the factors governing the quality of his output, in order that he may more satisfactorily compete with foreign manufacturers.

Other nations have realized the importance of this project and have already perfected elaborate plans for limiting to their own countries the distribution of information concerning the results of research work.

The Bureau is not alone in this undertaking, inasmuch as the National Council of Cotton Manufacturers of this country, which represents practically all cotton mills in the United States, has pledged its support to the furtherance of the Bureau's work on the investigation of cottons and has offered every cooperation that may be desired.

### Cotton.

The schedule or program of research work for the cotton mill is growing rapidly, and it is thought that the work on this schedule will soon be started, as the machine and equipment are in place and in operation. The investigation will be restricted to the making of yarns and fabric from the loom, but, as there are facilities for finishing the products, outside services will be requested when the present program is completed.

### Woolen and Felt.

The machinery, and equipment of these laboratories are rapidly being put in working condition, and it is expected that samples of work can be taken off in the near future to be investigated as to their physical and chemical properties in accordance with the research program.

## PAPER.

**(Testing of paper, physical, chemical, and microscopical; study and development of paper-testing devices; investigation of paper-making materials; standardization of paper; manufacture and development of special papers; study of the processes of paper manufacture; collection of data in connection with the testing and manufacture of paper.)**

### Routine Testing.

The amount of paper used by the Government departments is approximately 50,000 tons per year, and, as it is necessary for this material to be tested to see that it conforms to the specifications under which it was bought, standard methods of testing paper have been developed. This class of work is called routine testing and consists of chemical and physical tests and microanalysis. The chemical tests employed determine the amount of resin sizing that is in the paper, and the amount of filler and loading that has been added to give the paper bulk, opacity, finish, or surface. The physical tests used include the determination of weight, thickness, and bursting strength, as well as folding endurance and tensile strength for certain classes of paper. By means of selective stains and the aid of the microscope, the properties of fibrous material from which the paper was made can be estimated.

During the year 5,000 samples of paper were examined by these tests, of which 4,213 samples were submitted by the Government departments and 787 samples by public and private interests. A total of 19,545 tests were made on these samples, of which 5,395 were chemical, 9,655 were physical, and 4,495 were miscroscopical.

**Paper-Testing Methods.**

In the investigation of the properties of paper it is constantly necessary to study methods of testing this material, since the laboratory methods in general use are not suitable to determine certain qualities. It has, therefore, been found desirable to study test methods, and, wherever possible, develop a method that will give a numerical value for the qualities that are being investigated.

The property of paper which makes it possible to write with ink upon it is called "sizing." The sizing quality of paper is generally determined by methods that do give an empirical rating, but which are not very satisfactory for laboratory-research or mill-control work. A method for this purpose which, in its simplest form, is a Wheatstone bridge, used somewhat in recent years, is being further developed. By this method the penetration of water through a sheet of paper is measured by the increasing conductivity to an alternating current, which passes through the paper placed in a cell with an electrolyte. The data so obtained are plotted in the form of a curve, and from this curve the rate of penetration may be determined. It was found necessary to add a balancing cell which would reduce the variation of the test due to changes in temperature. As soon as the new apparatus is complete it is planned to study the curves obtained from tests on papers of varying sizing quality and, if possible, reduce these data to a unit basis.

The testing of the physical properties of paper has been investigated with a view to establishing any relationship that might exist between devices of the same general type and between devices that give an indication of different properties. The properties of paper studied in this investigation were bursting, tensile, and tearing strength. A series of papers were tested for bursting strength by three testing machines, and, although the data are not yet complete, it is indicated that the principle from which each machine was developed is based on experimental data rather than on scientific principles. Similar work was done in connection with tensile-strength testing apparatus, and it was found that there are no machines of American manufacture especially adapted to testing the tensile strength of paper. Since the quality of paper is so often judged by tearing a sheet in both directions, it was thought that a method for obtaining a numerical value for this property should be available. Three types of testing devices for this purpose are being studied—a recording mechanism, an apparatus of the balance type giving maximum strength, and an adapted tensile-testing machine from which a number of readings can be taken and an average obtained. It is felt that a study of this property in connection with formation of the sheet and the quality of the paper will be of considerable help to the manufacturer.

### Paper-Making Fibers.

Paper is, in general, a matted structure of fibrous materials, and it is possible to make a sheet of paper out of nearly every kind of fiber. In the development of the art of paper making a great many plants, weeds, grasses, etc., have been studied with a view to using them for the manufacture of paper, and especially the quality of paper resulting from their use. The available data on this subject are scattered, but are of great value. The work of compiling information on paper-making fibers is well started, and its scope is as broad as is consistent with the need of the industry. It includes a bibliography, authentic samples with descriptions, and microphotographs of the structure of these fibers.

The well-equipped photomicroscopical apparatus has been of great value in the study of fibers and has made it possible to obtain permanent records of the shape and structure of these fibers. As illustrations of the use to which this equipment has been put, samples of paper from Germany have been photographed, making it possible to duplicate them; it has been possible to obtain microphotographs of unusual specimens loaned to the paper section; and the study of Mexican hardwoods and other similar material has been undertaken.

### Felts Used on Paper Machines.

Woolen felts are an essential part of the equipment of a paper machine and play a very important rôle in the formation and quality of the paper produced. During the war the amount of wool available was greatly reduced, and it was thought possible to substitute a small amount of cotton for a portion of the wool in the felt.

Two felts were tested on the paper machine to determine the effect of the addition of 10 per cent of cotton to one of them. Each felt was run for five days on the paper machine, under as nearly similar conditions as it was possible to maintain. Exhaustive tests were made while paper was being run on the machine equipped with these felts, and it was found that the difference between the two felts was not large enough to affect the quality or the production of the paper. It is planned to investigate this problem further and determine whether felts made a greater percentage of cotton can be used satisfactorily on a paper machine. Since the life of a felt is only from three weeks to three months, depending on the machine, the speed, and the grade of paper, any satisfactory felt that can be manufactured more cheaply would lower running expenses.

### Utilization of Waste Cotton Linters.

At the conclusion of the war the War Department had on hand approximately 700,000 bales of " munition " linters available for other uses. " Linters " is a fibrous material which is left on the seed after the staple cotton had been detached. It was thought that this material would be suitable for paper making. At the request of the Waste Reclamation Service and the Industrial Cotton Seed Crushers' Association a series of runs was made on the paper machine to determine the quality of paper obtained. It was demonstrated that the paper made from this material was of good quality, free from dirt, and that such linters were a valuable paper-making material. It is to be noted, however, that the grade of linters used in these runs was "munition" linters and was unusually free from dirt and cinders. To demonstrate the possibility of making paper from cotton linters, the programs of the annual convention of the Interstate Cotton Seed Crushers' Association in New Orleans were printed on paper manufactured from this material on the paper machine of the paper section. Since about 700,000 bales per year of linters can be available for paper making, the value of this product as a raw material for the manufacture of paper is great; and if care is taken to keep the linters clean and free from dirt, a greater amount than this can be used for this purpose.

### Paper Bags for Lime and Cement.

The increasing use of paper bags as containers for lime and cement has made it desirable to investigate the properties of paper for this purpose. This work was discontinued during the war, but has been resumed. Representative samples have been obtained, and laboratory tests have been made to determine the quality of paper being used for this purpose. A test machine is being used that gives the stress-strain value of the paper, as well as the stretch under load. It is planned to develop a test that will reproduce the strain on the bag when it is dropped.

Due to the fact that no reliable information is available as to the relative merits of bags, it is necessary to determine what laboratory tests most nearly reproduce service conditions. This will be obtained by correlating laboratory tests, by developing new test methods, and by making service tests. As a result of this investigation it will be possible to define the qualities of paper necessary for bags for this type of work and to write suitable specifications. Manufacturers of paper, as well as the lime and cement associations, are cooperating in this work.

### Use of Lime and Limestone in the Paper Industry.

Lime and limestone play an important part in the manufacture of pulp and paper. The war has emphasized the value of lime as a chemical reagent, and it was felt that standard practice in the uses of chemical lime should be developed. A representative of the paper section has taken part in conferences of members of the Government departments interested in lime.

The use of lime and limestone in the pulp and paper industry is being investigated. It is planned to develop specifications for lime for the different industries, standard samples, and laboratory and plant methods of analysis.

In this work, technical committees of the pulp and paper industry will be consulted, and it is expected that the specifications and methods proposed will be accepted and used by this industry.

### Unbleached Pulp for Papers.

Chlorine from which bleach and bleaching powder is made was in great demand during the war for military purposes, and it became necessary to restrict the use of this chemical for the bleaching of pulp. It was, therefore, necessary to determine the effect on the color of paper that the restriction in the use of bleach would cause.

At the request of the War Industries Board, 21 runs were made on the paper machine using different proportions of dyestuffs with various unbleached pulps. As a result of the action of the War Industries Board, the amount of chlorine used in sulphite pulp was restricted to 40 per cent of the amount then used; in soda pulp, to 70 per cent; and in old papers, to 35 per cent. The use of chlorine for bleaching rags was restricted to 1 per cent.

### Filtering Paper for Gas Masks.

At the request of the Chemical Warfare Service, an investigation was undertaken to determine whether paper could be made in the United States similar to that being made abroad as a protection against "sneeze-gas." Tests were made on a commercial scale at two mills, and it was proved that such a paper could be made on a large scale in this country. Due to changes in the construction of the gas-mask canister, a different type of paper was desired, and 35 runs were made on the paper machine, producing a paper that was suitable for the purpose. It was found desirable to have a convenient method of testing this paper, and for this purpose a gas house was built. This house was so arranged that the gas would be formed in one room, and the paper tested in the next room by means of men wearing masks and breathing through flanges so constructed that the paper would act as a filtering diaphragm. In order to obtain a numerical value for the protection afforded by these papers, an apparatus was installed in the gas house that permitted a record being taken of the concentration of the gas before and after passing through the paper.

### Military Uses of Wall and Plaster Board.

During the war the investigation of wall and plaster board was continued from the previous year. Three camps visited at the time of their erection were, visited again to determine, if possible, the degree of durability of various makes of wall board. The results of the inspection show conclusively that almost any wall board properly erected will give satisfaction in cantonment construction when the buildings are considered as temporary structures. Many of the buildings were in poor condition, due almost entirely to the poor method of erection. All wall boards will expand and contract under different atmospheric conditions, and this expansion and contraction is injurious if the board is nailed at the edges. Wall board should be nailed along the center and the edges but lightly nailed, and then well stripped with pieces of wood to cover the joint and to allow for the expansion and construction of the board underneath the wooden strips.

In order that further information might be obtained as to the behavior of these boards under service conditions, a questionnaire was sent to most of the military cantonments. For temporary structures fiber wall board was preferred, merely because it was considered quicker and cheaper to erect and because of its greater salvage possibilities. Plaster board was preferred for permanent construction—that is, over five years—because it was considered less subject to changes in temperature and because it makes a warmer building. For hospital use plaster board was preferred, due to its greater resistivity to fire and moisture.

### Miscellaneous Information Furnished Public and Private Interests.

Specifications have been developed for a small paper mill for the Siamese Government. Drawings were made of the plan for such a mill, and information was obtained as to manufacturers and prices for such equipment.

Plans and necessary equipment for a paper-testing laboratory were outlined for the Australian Government, in connection with the investigation of Australian hardwoods for the manufacture of paper.

The development of the manufacture of blue-print paper was assisted by tests on 75 samples of this paper for a manufacturing concern. These data are to be correlated with manufacturing conditions.

Considerable assistance has been given the Forest Service in the work of revising the commodity classification of pulp and papers. This classification is used in connection with the collection of data of foreign and domestic commerce.

Further work was done in the development of paper containers for export shipment of saddle soap and grease for the War Department. Another use of paper containers under consideration was a carton to carry machine-gun cartridges. This last was to be a part of a new feeding mechanism for machine guns, by the use of which the belt would be eliminated.

Technical assistance was given the Federal Trade Commission in reference to definitions of paper terms which were claimed by that commission to be cases of misbranding. The terms in question were bond, vellum, parchment, Madras, nainsook, etc.

Miscellaneous information has been furnished Government departments in connection with specifications for paper, the testing of paper, and the standardization of paper. Specifications have been developed for private interests for special papers. Information is being collected continuously on paper testing, paper-making materials, and paper-manufacturing methods. In connection with the information an exhibit is being prepared of papers and paper-making materials.

## 8. METALLURGY.

[Thermal analysis and structure of metals, heat treatment and its effects upon the properties of metals and alloys, including the researches involved in determining the causes of metal failures, cooling and heating curves; the investigation of hardening, annealing, tempering, cementation; the determination of critical ranges; and the preparation of pure metals and alloys.]

### GENERAL ACTIVITIES.

### Cooperation with Societies and Boards.

The following paragraphs give the membership during the past year of the members of the metallurgical division in the several scientific and technical societies of which they are members, and also their relation to various Government boards and committees.

Among the activities of importance may be mentioned particularly that the chief of the metallurgical division served as the representative of the Department of Commerce on the Requirements Division of the War Industries Board. This gave an opportunity for the Department to take an active interest in and be helped in many exceedingly important matters coming before the Government. Another member of the staff was very helpful as adviser in ceramics to the War Industries Board and in framing specifications for enameled ware as a member of the Army Committee on Standardization. Another rendered valuable service as a member of the Interdepartmental Committee on Minerals and their Derivatives and in blocking out and aiding in the manganese conservation program. The committee on light alloys of the National Advisory Committee for Aeronautics did most of its experimental work through the Bureau of Standards, and the results of this have appeared in a series of publications. The relations of the Bureau to the American Society for Testing Materials have been very close, and several members of the metallurgical division have been very active in the committee and aiding in the framing of specifications and in presenting for publication standards and properties of metals. The National Research Council has actively cooperated with the Bureau in several problems, and the Bureau representatives are active on some 11 of its committees. The American Institute of Mining and Metallurgical Engineers is holding a symposium upon pyrometry this fall which promises to be a scientific and technical event of great importance. This has been arranged for very largely by the staff of the metallurgical division. Among the important committees formed by the Research Council during the war was one to make a survey and recommend practice as to the ingot and finishing practices in American steel mills. This work originated in the Army Ordnance in connection with the works practice as influencing the output of steel. At a recent meeting of this committee it was decided, however, not to promulgate descriptions of good practice, although the committee had access to a fund of knowledge on this subject.

During the year the metallurgical staff have cooperated with the following committees and organizations: American Ceramics Society; American Institute of Mining and Metallurgical Engineers; American Physical Society; American Society for Testing Materials; American Welding Society; National Advisory Committee for Aeronautics; National Research Council; Technical Staff of the Ordnance Department of the Army; War Service Association of Manufacturers of Bearing Metals and Solders; War Industries Board; Engineering Standards Committee; Interdepartmental Committee; Society of Automotive Engineers; and International Aircraft Standards Board.

### Exhibits of War Activities.

An exhibit of scientific development in connection with the war was held at the Bureau by the American Physical Society which was very largely attended, there being a program limited to war topics. There was also a very extensive exhibit of war developments in physics with entries from manufacturers and Government bureaus. The various sections of the Bureau contributed much to the exhibit.

### Committee on Nonferrous Alloys.

The committee on nonferrous alloys has resumed its meetings, and is advising very actively with the Bureau on its experimental program and is of very considerable assistance in aiding the Bureau in outlining its investigations of nonferrous alloys.

### Conferences.

Conferences have been held at the Bureau on copper pressure plugs for testing ammunition, and a great many informal conferences have been held on many subjects related to specifications and other phases of the Bureau's experimental work; both testing and research in metallurgy.

### Publications in Metallurgy.

The publications by the staff of the metallurgical division include the following, which have appeared during the year:

Effect of Rate of Temperature Change on the Transformations in an Alloy Steel (H. Scott): Bureau of Standards Scientific Paper No. 335; Bulletin of the American Institute of Mining and Metallurgical Engineers, vol. 146, p. 157; 1919.

Protective Metallic Coatings for the Rustproofing of Iron and Steel (Rawdon, Finn, and Grossman): Bureau of Standards Circular No. 80; Chemical and Metallurgical Engineering, vol. 120, pp. 458, 530, 591, 1918; fourth meeting, Annual Report of the National Advisory Committee for Aeronautics.

Microstructure of Flaky Steel (H. S. Rawdon): Bulletin of the American Institute of Mining and Metallurgical Engineers, vol. 148, p. 183; 1919.

A Critical Study of the Ledebur Method for Determining Oxygen in Iron and Steel (Cain and Pettijohn): Technologic Paper of the Bureau of Standards No. 118.

Study of the Goutal Method of Determining Carbon Monoxide and Dioxide in Steels (Cain and Pettijohn): Bureau of Standards Technologic Paper No. 126.

Report of Ladle-Test Ingot Investigation (J. R. Cain and H. S. Rawdon); Appendix of Report of Committee A–1 of the American Society for Testing Materials; 1919.

Heat Treatment of Duralumin (Merica, Waltenberg, and Scott): Bulletin of the American Institute of Mining and Metallurgical Engineers, vol. 150, p. 918; June, 1919.

Constitution and Metallography of Aluminum and Its Light Alloys with Coppér and Magnesium (Merica, Waltenberg, and Freeman): Bureau of Standards Scientific Paper No. 337; Bulletin of the American Institute of Mining and Metallurgical Engineers, vol. 151, p. 1031; 1919.

Mechanical Properties and Resistance to Corrosion of Rolled Light Alloys of Aluminum and Magnesium with Copper, with Nickel, and with Manganese (Merica, Waltenberg, and Finn): Bureau of Standards Technologic Paper No. 132; Bulletin of the American Institute of Mining and Metallurgical Engineers, vol. 151, p. 1051; 1919.

Comparative Tests of Palau and Rhotanium Ware as Substitutes for Platinum Laboratory Utensils (Gurevich and Wichers): Journal of Industrial and Engineering Chemistry, vol. 11, p. 570; 1919.

Science and the After-War Period (Burgess): Scientific Monthly, February, 1919; Journal of Washington Academy of Sciences, vol. 9, p. 57; 1919.

Conservation of Tin in Bronzes, Bearing Metals, and Solders (Burgess and Woodward): Bureau of Standards Technologic Paper No. 109; Transactions of the American Institute of Mining and Metallurgical Engineers, p. 1742; 1918.

Behavior of Wrought Manganese Bronze Exposed to Corrosion While Under Tensile Stress (Merica and Woodward): Bureau of Standards Technologic Paper No. 135; Proceeding of the American Society for Testing Materials; 1919.

Aluminum and Its Light Alloys (Merica): Bureau of Standards, Circular No. 76; Chemical and Metallurgical Engineering, vol. 19; 1918.

Solders for Aluminum (Merica and Gurevich): Bureau of Standards, Circular No. 78; Metal Industry, p. 500; 1918.

Recent Metallurgical Work at the Bureau of Standards (Burgess): In Blast Furnace and Steel Plant; May, 1919.

Letter Circular on Properties of Light Aluminum Alloys (Merica).

The following are in course of preparation or in press:

The Study of the Deterioration of Nickel Spark-Plug Electrodes (Rawdon).

Notes on the Microstructure of Iron and Mild Steel at High Temperatures (Rawdon and Scott).

Metallography Structure and the Related Properties of Metals; A Revision of Circular No. 42 on Metallographic Testing (Rawdon).

An Electrolytic Resistance Method for Determining Carbon in Steel (Cain and Maxwell).

Equilibrium Conditions in the System Iron Oxide; Carbon and Hydrogen in Relation to the Ledebur Method for Determining Oxygen in Steel (Cain and Adler).

Oxygen Content by the Ledebur Method of Acid Bessemer Steels Deoxidized in Various Ways (Cain and Pettijohn).

Investigations at the Bureau of Standards on Gases in Steel and on Deoxidization of Steel (Cain).

Cements for Spark-Plug Electrodes (Staley).

The Use of a Modified Rosenhain Furnace for Thermal Analysis (Scott and Freeman).

Manufacture and Properties of Light-Wall Structural Tubing (French).

Circular on Alloy Steels (French).

Thermal Critical Ranges of Low-Nickel Steels (Scott).

Simplification of Inverse Method of Thermal Analyses (Merica); Bulletin of the American Institute of Mining and Metallurgical Engineers, vol. 151, p. 1021; 1919.

Tin Fusible Boiler Plug Manufacture and Testing (Gurevich and Hromatko).

Embrittling of Steel by Pickling and Plating (Grossman and Langdon).

Properties of Certain Lead-Zinc Bronzes (Staley and Karr).

Five Foundry Tests of Zinc Bronzes (Karr).

Report of the Pyrometer Committee of the National Research Council (Burgess).

Some Tests of Light Aluminum Cast Alloys (Merica and Karr).

Circular on Nickel (Merica).

Aluminum-Magnesium Mirrors (Waltenberg and Coblentz); for Physical Society.

Metals for Pyrometer Standardization (Burgess and Waldner).

The Testing of Clays for Foundry Uses (Staley).

### Metallurgical Tests.

Many of the tests performed by the metallurgical division are of an elaborate nature, oftentimes entail a very considerable amount of experimental investigation, and include all phases of qualities of metals and alloys, as well as determinations of causes of metal failures and of serviceability of metals.

### Work for the Ordnance Department of the Army.

As an illustration of the type of work being done in detail for several of the military establishments during the war, the work performed for and in cooperation with the Ordnance Department may be cited as an example. The several experimental researches and investigations are described elsewhere. The very considerable amount of testing performed may be emphasized here, however. The Gun Section of the Ordnance Department provided considerable equipment for carrying out routine tests of gun steel to supplement and explain results obtained in the tension tests of samples taken from gun forgings and to show the heat treatment suitable for controlling the microstructure of large guns in forging. Examinations show that the heat treatment of gun forging has been, on the whole, satisfactorily carried out and that the inferior properties encountered are generally due to the nonmetallic impurities. Similarly, a systematic series of tests was made on 3-inch brass cartridge cases, representing the product of several manufacturers, which were studied by various methods. A general study of the defects in slugs intended for the manufacture of shrapnel cases was made, as also examinations of copper rotating bands, and a great many samples of failed metals for ordnance purposes.

### Testing.

The items formally entered as tests are summarized in the accompanying table:

| | Heat treatment and thermal analysis. | | Metallographic (including physical, chemical, and corrosion tests.) | | | | Fusible plugs. | Miscellaneous. | Grand total. |
|---|---|---|---|---|---|---|---|---|---|
| | Irons and steels. | Nonferrous metals. | Irons and steels. | Aluminum alloys. | Brass and bronze. | Other metals. | | | |
| For the Government: | | | | | | | | | |
| Bureau of Standards | 31 | 4 | 79 | ...... | ...... | 13 | ...... | ...... | 127 |
| Council of National Defense | 8 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 8 |
| Emergency Fleet Corporation | ...... | ...... | 1 | ...... | ...... | 1 | ...... | ...... | 2 |
| Navy Department | 1 | ...... | ...... | ...... | ...... | 2 | ...... | 6 | 9 |
| Panama Canal | ...... | ...... | 8 | ...... | ...... | 9 | ...... | 2 | 19 |
| Patent Office | 1 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 1 |
| Steamboat-Inspection Service | ...... | ...... | ...... | ...... | ...... | ...... | 498 | ...... | 498 |
| War Department | 21 | 2 | 134 | 4 | ...... | 5 | ...... | ...... | 166 |
| War Industries Board | 1 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 1 |
| Coast and Geodetic Survey | ...... | ...... | ...... | ...... | 1 | ...... | ...... | ...... | 1 |
| Total | 63 | 6 | 222 | 4 | 1 | 30 | 498 | 8 | 832 |
| For the public | 3 | ...... | 3 | ...... | 2 | 8 | ...... | 6 | 22 |
| Grand total | 66 | 6 | 225 | 4 | 3 | 38 | 498 | 14 | 854 |

### Correspondence.

The metallurgical division carries on a correspondence on a great variety of subjects concerning metals. A typical list is that for the month of February, 1919, as follows: Treating black-iron plates and rods; characteristics of boiler plugs; formulas and specifications for brasses, bronzes, and Babbitt metals; zirconium steels; heat treatment of instrument diaphragms; report to Quartermaster Corps on tests of china and porcelain ware; methods of porcelainizing; comparative merits of nickel chromium and nickel steel for resistance wire; porosity in metals; cracks in enameled metals; solder aluminum joints; car-wheel accidents; metallography of aluminum; publication on aluminum alloys; properties of zinc sheet; steel castings by electric furnace; deteriorations of coatings on copper wire; tests for sharpness; railroad bearings; heat treatment of steel; effect of temperature on strength of bronzes; aluminum-casting alloys; use of uranium; properties of zirconium; supply of invar; stainless steel; corrosion of aluminum by lead; recalescence points of steel; alloy steels; aging of brass; collapsible tubes; noncorrodible steels; pure nickel; Kermat nickel; enameling; hardness of copper; new bronzes; metal for valves; specifications for nails; annealing of phosphor-bronze wire; identification tags; Meinheim-chamber furnace system; gases in steel; cooperite and stellite; literature on steel, iron, and bronzes; heat treatment of rivets, bars, and springs; alloying and refining of gold and platinum; Monel metal; thermal analysis standards; characteristics of high-speed steels; oxidation of brass; the recovery of copper from shell cases; utilization of scrap aluminum; practical welding; copper-lead alloys; manufacture of magnesium; tin-lead alloys for coating copper; drawing of aluminum sheet; metals for ship construction; core oils for foundry sands; small gas crucible furnaces; heat-treating equipment; acid-proof iron alloys; manufacture of tin foil; copper-bearing metal; transformation-points recorder; properties of magnalium; furnace fire bricks; open-hearth special steels; bearing metals for tractors; standard tests for bearing metals; bario metal; substitution of aluminum alloys for instrument brass.

### Problems of Military Interest.

The Bureau has developed very close relations with several of the technical military establishments, including branches of the General Staff, the Army and Navy Ordnance Bureaus, the Aircraft Production, the Corps of Engineers, the Signal Corps, and the Quartermaster's Department. In particular, and as illustrative of the type of work in cooperation, may be given a statement regarding some of the problems with which the Bureau is working in cooperation with the technical staff of the Army Ordnance which maintains several men at the Bureau for work on problems in which they are interested.

*Test-Bar Fractures.*—The Ordnance Department had accumulated a very considerable number of fractured test bars as a result of an examination of many thousands of samples of steel, and it was thought desirable to make a statistical and systematic study of the fractures produced in tension, methods of photographing, and an explanation and description of the various characteristic features by relating them with the structure of the tension bars. The aim is to embody the results of this work in the form of a manual which may be furnished to inspectors.

*Hardness of Brass Cartridge Cases.*—Another problem is the investigation of the hardness of brass cartridge cases by means of the micro-Brinell-hardness machine developed by the Ordnance Department during the war. The hardness study will be supplemented by a study of the microstructure of the material, determination of mechanical properties, mainly in tension, and their behavior as regards corrosion cracking. The aim is to supplement the various descriptive tests now made of brass cartridge cases. A considerable amount of work was also done by the Bureau in the examination of cartridge cases during the war, for the purpose of finding the effects of various methods of manufacturing upon the properties of the finished material and with a view to aiding the Ordnance Department in its inspection and specification service.

*Machine-Gun Erosion.*—A systematic study of this subject is being made from the metallurgical point of view, including the preparation of a considerable number of special steels, determination of the interesting physical properties, and the ballistic tests, which last are being conducted by the Ordnance Department itself.

*Copper Crusher Gauges.*—At the request of the Society of American Manufacturers of Small Arms and Ammunition and of the Ordnance Department, the Bureau has been actively engaged in the preparation of specifications for copper crusher gauges for testing ammunition and standardizing the method of use. A considerable amount of work has also been done on the characteristics of the copper crusher cylinders, particularly as related to their properties under various conditions of annealing and as dependent upon their conditions of precompression, and includes a study of the resulting errors. Several conferences have been held, and it is expected shortly to close this subject.

*Centrifugal-Steel Castings.*—It was considered desirable to study the properties of ingots cast by the Millspaugh centrifugal method. This method produces an ingot of hollow cylindrical form, and it was thought that there would be a considerable saving of material, labor, and time in the manufacture of cylindrical steel appliances. If the method warranted, it was hoped to be able to substitute cast or heat-treated cast material made by this centrifugal process for forged pieces. The castings submitted for examination were a miscellaneous assortment of four of several chemical compositions and cast under various conditions, but none of the cylinders being cast strictly in accordance with specification requirements for ordnance material. Very interesting and promising results were obtained.

Segregation of the elements—carbon, sulphur, and phosphorus—appears to exist only radially and is confined mainly to a very thin layer of the inner zone, but exists also slightly in the outer zone. Nickel also appears to segregate somewhat, following the carbon. The maximum carbon segregation found amounted to 0.09 per cent in a steel containing 0.66 carbon and nickel 2.2 per cent. Blowholes appear only in the inner segregative zone. The density across a section is practically constant; tensile and shock tests show in general greater strength and elasticity, but less ductility in tangential than in longitudinal directions. This method of casting develops very slight internal stresses. By suitable heat treatment the physical properties of steel cast by this method compare very favorably with forged material of the same composition. The metal of the casting is clean and sound and its microstructure better than in ordinary types of steel casting.

*Magnesium Aluminum Alloys for Mirrors.*—The Signal Corps and the Corps of Engineers were much interested in the development of a light metallic mirror material of high-reflecting power, and it was desired, if possible, to realize mirrors of diameter up to 6 feet. The Bureau undertook the investigation of aluminum-magnesium alloys for mirrors, and although it was found impracticable to build such large mirrors it was found that the compound $Al_3Mg_4$, containing 50 per cent magnesium, gave a reflection of 85 in the blue and 93 in the red and that this could be made mechanically satisfactory by a vacuum melting and heat treatment. Although this alloy resists action of dilute acids and alkalies much more than any other AlMg alloy that has come under our observation, it is not recommended where permanency is of prime importance, as some of the samples showed evidences of slight contamination after standing several months in the laboratory.

*Corrosion of Aluminum Alloys.*—One of the problems in which the National Advisory Committee for Aeronautics and also the Navy Department were greatly interested is the effects of corrosion, particularly under sea-water conditions, on aluminum alloys such as those used in airplane manufacture. A systematic program of experiments and exposure tests have been started and is still under way. A number of the alloys covered with various protective coatings, together with unprotective sheets, are being exposed to the action of the atmosphere and sea water at three widely differing latitudes to determine the best alloy and coating to be used in seaplane construction.

*Steel Helmets for the United States Army.*—Some work was carried out for the National Research Council in connection with certain problems arising in the manufacture of steel helmets:

(1) To determine whether heating up to quenching temperature in the heat treatment of helmets following the pressing operations was sufficient to remove the stresses set up during the pressing. The average results of tests showed that heating of test pieces of helmet steel to 825° C. and cooling quickly in a furnace reduced the amount of stresses by about 60 per cent, while those test pieces heated to a like temperature and cooled slowly in a furnace showing a reduction of some 73 per cent as compared with the amount of stresses found present in the test pieces which were not heat treated; that is, in the original or pressed condition.

(2) Determination of length of time needed to hold helmet steels at the quenching temperature to get full hardening on quenching. Helmet steels of 11 compositions were also examined to determine their critical ranges in connection with the development of tests for determining resistance to deformation and penetration.

*Effect of Prolonged Annealing High-Silicon Cast Iron (Duriron).*—The Inspection Division of the Ordnance Department, which was interested in the use of noncorrodible iron of the type of "duriron" (cast iron of the approximate composition—total carbon, 1.18 per cent; graphite, 1.09; silicon, 13 per cent)—requested the Bureau to determine the possibility of any changes in composition upon continued heating. The examination showed that continued heating for as long as 50 hours at 1,000° C. produced no essential change either in structure or composition.

*Horseshoe Nails.*—At the request of the General Engineer Depot, United States Army, an examination was made of nails representative of most of the manufacturers of this type of material, with the aim of drawing up specifications. The examination showed a rather wide variance in the type of steel used (0.07 to 0.20 per cent carbon) in the process, some being hot forged, others cold-stamped. A simple type of impact test using a notched specimen was recommended for determining the relative merits of different types of nails.

*Deterioration of Nichrome Castings Upon Heating.*—The attention of the Bureau was called to this problem by the Chemical Warfare Service. The large nichrome castings in the form of tubes used for the production of charcoal for gas masks deteriorated rather rapidly in service, becoming weak and brittle. The examination made of the material showed that, contrary to the opinion expressed by other investigators of this problem, the deterioration does not consist in the formation of a carbide by interaction with the charcoal. On the other hand, the carbide normally present in the nichrome is removed. An intercrystalline brittleness, apparently identical with that of nichrome wires upon continued heating, is produced, the exact nature and cause of which have not yet been determined.

*The Relative Cutting Properties of "Cooperite" and "Stellite."*—At the request of the Bureau of Ordnance, Navy Department, a test was undertaken to show the relative cutting properties of the two alloys "stellite" and "cooperite." These two alloys, though quite different in chemical composition, have very similar mechanical properties; they are very hard and able to "keep an edge" at a rather high temperature. They are used, particularly stellite, quite extensively to replace and supplement high-speed steel tools for cutting. Cooperite is essentially an alloy of nickel and zirconium with appreciable amounts of iron and silicon. Stellite, which is manufactured in several different grades, is a rather complex alloy, the essential elements of which are cobalt, chromium, tungsten, and molybdenum.

The series of service tests made showed that cooperite is but slightly inferior to the better grades of stellite. Lathe tools made of cooperite failed after a cut of 4-inch lengths made on a 5-inch round of nickel-chromium steel under the following conditions: Speed, 226 feet per minute; feed, 0.0135; depth of higher speed, 240 feet per minute; the other conditions being the same, but for a length of 8 inches before failure occurred.

*Defects in Shrapnel Steel.*—At the request of the inspection division, Ordnance Department, an extensive and detailed study of the defects in steel slugs intended for the manufacture of shrapnel cases, as revealed in the fracture by the "nick-and-break" test, was made. This was supplemented by a study of slugs which had been sheared as well as broken by the "nick-and-break," the aim being to show whether shearing could be substituted for the latter method in the work of inspection. The results of the examination, however, did not appear to warrant a recommendation from the Bureau for the proposed change in the method of inspection of this class of materials.

*Light Armor Plate.*—In cooperation with the Bureau of Mines and the Navy Department the Bureau is studying the properties of special alloy steels suitable for the development of light armor. The majority of these steels contain zirconium, while others contain molybdenum, boron, cerium, etc. About 150 ingots have been made by the Bureau of Mines Experiment Station at Ithaca, N. Y., and have been rolled into plates of three-eighths or one-half inch thickness at the Bureau of Standards. The properties of these materials are being thoroughly examined, including mechanical properties, heat treated and annealed, hardness, resistance to impact, microstructure, chemical analysis, and thermal analysis. In conjunction with the ballistic tests to be made by the Navy Department valuable and useful data will be obtained for the design of light armor plate.

*Liquid Forging of Light Aluminum Alloys.*—The Morris engineering process was investigated in cooperation with the Naval Gun Factory. This process gives a highly satisfactory alloy for aero-to cast or die-cast metal, being of increased strength and ductility and free from blowholes and other imperfections.

*Corrosion of Aluminum Carburetors.*—This is a problem in which the Aircraft Production Bureau was very much interested. Its importance lies in the fact that particles of sludge resulting from the corrosion taking place in the float chambers of aluminum carburetors lodged in the atomizers and stopped the flow of gasoline. The relation of the composition of cast aluminum to corrosion is being studied, and various protective coatings are being investigated.

*Miscellaneous.*—Another problem on which some work has been done is an examination of causes of failure due to excessive stress developed in certain parts of the Browning machine gun; as, for instance, bottom plates which split under impact. It would appear that heretofore an inferior grade of steel has been used for this piece.

The Bureau of Aircraft Production was interested in finding a solder of intermediate melting point. A satisfactory special solder was developed by the Bureau of a melting point of approximately 400° C. Its composition is 40 silver, 40 tin, 14 copper, and 6 zinc.

## RESEARCH AID TO MANUFACTURERS.

It is the policy of the Bureau to aid manufacturers in the solution of their technical problems, and the following list of investigations will give an idea of the kind of help that it has been possible to render during the past year. This list does not include all the items of such nature, but those given are typical.

### Manufacture of Collapsible Tin Tubes.

At the request of one of the large manufacturers of this class of material, the Bureau undertook the investigation of certain defects which often occur on the surfaces of such tubes. These defects consist of discolorations, which interfere seriously in the use of light enamels on such tubes. The study made of this problem, which included a conference with the manufacturer at the plant, showed that one type of surface stain was due to sulphide fumes, the effect being localized and accentuated at certain spots by traces of acid in the perspiration of the hands touching them. Other surface defects, usually as streaks, were pointed out as due to contamination with free sulphur, some of which occurred in the compound used for lubricating the disks from which the tubes were extruded.

### Annealing of Hard Cold-Worked Nickel-Brass.

As part of the study made by this Bureau of metals suitable for diaphragms of various types of aeronautic pressure instruments the behavior of cold-worked nickel-brass, which is used largely for such diaphragms, was examined. In the cold-worked sheets the "work lines" to which the hardness is due are very pronounced. Upon annealing, these "work lines" are gradually erased; heating for 20 minutes at 500° C. is sufficient to remove them entirely. The disappearance of these lines or bands may be taken as an indication of the rate at which the hardness due to mechanical working is removed. Above 500° C. the nickel-brass increases rather rapidly in grain size and becomes soft and ductile.

### Copper-Lead Bearing Metals.

Several samples of alloys of lead and copper proposed for use as bearing metals have been submitted for examination. The lead content in some is as high as approximately 50 per cent; for example, in "ulcoloy." Lead and copper do not alloy to any appreciable extent; the resulting mixture of the two elements is a "sponge" of copper the interstices of which are filled with metallic lead. The size of the lead globules, which is dependent upon the rate of cooling and the mechanical agitation, determines largely the efficiency of the metal for use in bearings. The principal objection to the lead-copper bearing alloys appears to be the difficulty of reproducing the structure upon remelting for pouring.

### Deterioration of Zinc-Aluminum Die-Casting Alloys.

The behavior of an alloy of the composition—zinc 83.4 per cent, aluminum 15.2 per cent, copper 1.4 per cent—was studied in a series of tests which were chosen so as to approximate the extreme conditions of service.

Immersion in water causes no appreciable change in the alloy, nor does dry heat, at least up to 100° C. Moist heat (100° C.), on the contrary, produces a pronounced swelling of the specimens in as short a time as six days. An increase of 7.7 per cent in one of the dimensions of the specimens occurred in 12 days, and the surface of the allow became covered with "alligator" cracks. Evidently this alloy, which may be taken as typical of aluminum-zinc alloys of high zinc content in general, can not be relied upon for die castings in hot, moist climates.

### Sterling Silverware.

The advice and help of the Bureau was requested by one of the large manufacturers of silverware during the past year concerning two different types of defects which appear at times on the surface of the finished article. Though not serious, these imperfections impair the high finish and polish which are desired for this class of materials. One type of spot occurs upon standing, and appears to be due to tiny inclusions of the cyanide bath used for annealing; other discolorations are due to surface oxidation of the copper, which is intentionally added to silver to harden it.

### Sharpness Standards.

At the request of manufacturers of razors and cutlery, an attempt is being made to devise methods for measuring and defining sharpness of fine cutting edges. This is practically a new field of research, and there is little or no available or published experience to serve as a basis.

## MICROSCOPY AND STRUCTURE.

### Protective Metallic Coatings for Rustproofing Iron and Steel.

The results of the Bureau's experience in the study and testing of coated metals, together with a résumé of a study of the available technical literature, have been embodied in Circular No. 80 of the Bureau series. The frequent inquiries for reliable information along this line rendered the circular a necessary one.

The Bureau, in cooperation with a committee of the American Society for Testing Materials, has been carrying out an extensive program on the investigation of the properties and testing methods as applied to zinc-coated metals. An extensive series of exposure tests of such metals is being arranged.

### Nickel Spark-Plug Electrodes.

A study of the deterioration of the nickel terminals of the spark plugs used in internal-combustion engines was made at the request of one of the large manufacturers of this type of material. The study was extended to include other types of plugs. The brittleness which results in the electrodes upon usage was shown to be a characteristic property of nickel wire and must be expected to occur to some extent in all types of plugs. Deterioration is much more rapid in some types than in others, due to the stresses to which the wires are subjected while hot. These stresses, in turn, depend upon the arrangement and shape of the electrodes. The results of the study will appear as a Bureau scientific paper.

### Cements for Spark-Plug Electrodes.

The use of cements for welding electrodes to spark-plug porcelains has been found to be attended by various difficulties in high-temperature engines such as are used in airplanes. Among these difficulties are promotion of oxidation and destruction of electrode wires by reactions taking place in the cements and between the cement and electrode wires; breaking of porcelain caused by difference in coefficients of thermal expansion of electrode wires and porcelain; and the cracking of cement with consequent gas leakage, due to the same cause. A cement composed of silicate of soda and raw kaolin has been found to give little trouble from chemical action. In order to avoid the difficulties attending the use of any form of cement, the use of a mechanical seal at the top of the porcelain has been tried with promising results.

### Special Steels.

As part of the study which is being made by the Bureau of "zirconium" and other special steels, a study has been started to demonstrate the rôle which zirconium and titanium play in such steels in the endeavor to explain the effect of additions of these elements upon the physical properties of the resulting steel.

### Corrosion of Nonferrous Alloys.

During the year, at the request of the Navy Department, a comprehensive program for the study of the corrosion of nonferrous alloys (particularly copper alloys) was prepared. The Navy Department was to assist in this work by furnishing materials and in arranging for exposure tests in sea water. Due to changed conditions, the material has not been furnished and the work not started as yet. The subject will be taken up in the near future, however, it is hoped.

### Study of "Deep Etching" of Metals.

A study of the deep etching of iron and steel has been started. The aim is to show the influence of the various possible factors—chemical heterogeneity (segregation), physical heterogeneity (variations in crystal size, presence of intercrystalline discontinuities, etc.), and mechanical heterogeneity (internal stresses, etc.). The study of the macrostructure of metals has in general received much less attention from metallographists than the microstructure.

### Microstructure of Pure Iron and Mild Steel at High Temperature.

An investigation on this subject has just been completed. Its aim has been to show how much the change in composition of the surface layer, which usually accompanies heating in vacuo, affects the results of tests made to reveal the microstructure existing at high temperatures. The results also throw some additional light upon the nature of the composition change of the surface layer, and also the formation of the surface pattern by which the microstructure is revealed by means of "heat-relief" etching.

**"Flaky Steel."**

Examinations were made of numerous specimens of defective gun steel and airplane crankshaft stock which showed this type of defect. The defect termed "flake" appears as a shining, coarse, crystalline area in the midst of otherwise sound material. The flake, which may be as large as 1 centimeter in diameter, has the appearance of an intercrystalline discontinuity in the steel and is very often (if not always) associated with steel which is badly contaminated with slag and similar inclusions. "Flakes" reduce the ductility of steel, although the ultimate strength of the material (in tension) is not affected nearly so much. They are particularly injurious in material exposed to repeated stresses. The study of this material is being continued, and particular attention will be given to the effect of forging and heat treatment upon such material.

**Pearlite in Steel.**

A study is being made of the state of pearlite in selected steels of varying chemical compositions after they have been subjected to diverse heat treatments. This is a continuation of some previous researches of Messrs. Howe and Levy. The experimental work has been practically completed, and this will appear shortly as a bureau publication.

**Welding Research.**

Several national bodies have been interested in furthering our knowledge of means for improving methods of welding. The Bureau has been working in cooperation with the Electric-Welding Committee of the Emergency Fleet Corporation and later with the Research Committee of the American Welding Society. The metallurgical division has been concerned with such questions as outlining specifications for metallographic examination and experimental study of the relations of structure to brittleness in welds; this is being carried out both on material from American manufacture and material furnished by the British Admiralty. The resistance to corrosion of different types of welds, including solubility of acids, in which it appears that the usual types of joints will not corrode faster than a riveted joint, was also investigated. The investigation will also include the effects of the presence of gases entrained in welds; the identification and rôle of certain constituents considered harmful, such as the nitrides of iron, and the development of nondestructive tests for welds. Incidentally, a considerable number of welds of various types have been prepared for physical tests.

## HEAT TREATMENT AND THERMAL ANALYSIS.

During the past year the experimental heat-treating plant has been enlarged. An electric muffle furnace and two gas-fired metal and salt-bath furnaces have been installed, and, in addition, the pyrometer equipment for individual units has been changed to a central-station control. Among the smaller units installed have been an electric salt bath for annealing and an electric tube furnace for use in determining tensile properties of metals at high temperatures. A most important addition has been the construction from designs of the members of the staff of a modified Rosenhain furnace for taking heating and cooling curves. This furnace does away with the necessity of varying the heating current. Changes in temperature of the samples studied are produced by raising and lowering the sample in the furnace kept at constant temperature.

### New Method for Thermal Analysis.

A new method for making thermal analysis was developed. The usual practice of recording inverse heating and cooling curves is to record with a chronograph the consecutive time intervals. This involves the use of a relatively expensive apparatus now difficult to obtain. It is also necessary in this method to count the time intervals from the chronograph sheet, a process requiring one or two hours. It has been found that these time intervals could be recorded as accurately and almost as conveniently by two stop watches, which thus serve as a cheap substitute for a chronograph. By this process, also, much time is conserved.

### Iron-Carbon Transformations.

Considerable progress has been made in the investigation of the transformations in pure iron-carbon alloys, and the results so far obtained have shown some unexpected phenomena of considerable importance. According to the present outline, this investigation will probably be completed during the coming year. The transformations in pure iron-carbon alloys are of great importance, as they form a basis for determining the effect of the alloying elements used in producing alloy steels, and also in the determination of the effect of impurities normally present in small and varying quantities in plain carbon steels. An accurate knowledge of the position and character of these thermal transformations is also of great practical value, as they form a basis for estimating the temperature of the transformations in steels from the chemical analysis, which will eventually eliminate the necessity for commercial apparatus for this purpose.

A study is now being made of the critical ranges of certain nickel-silicon, armor-plate steels in connection with an investigation of the mechanical properties of these alloys. This work includes the independent effect of both nickel and silicon, and also additions of rare elements in small quantities, on the thermal critical ranges in order that correct heat-treatment temperatures may be estimated.

A study of the effect of other alloying elements added to pure iron-carbon alloys is contemplated.

### Magnetic and Density Tests.

As fundamental to the interpretation of magnetic tests on heat-treated steels, a correlation of the magnetic properties of a carbon steel with physical properties and microstructure has been undertaken. Magnetic analysis has recently received considerable attention throughout the country, and it is expected that the results obtained will add considerably to our present knowledge of this subject.

Magnetic tests are also being made on a high chromium steel under varying thermal treatments to determine suitability for permanent magnets.

Density determinations are also being made on a series of alloy steels to determine which are the least susceptible to dimensional changes in hardening.

### Mechanical Properties.

To throw further light on the effect of varying heat treatments on the mechanical properties of various structural alloy steels an investigation is now under way to correlate the tensile properties with impact and fatigue values obtained with various machines now in use throughout the country, and also with results obtained from torsion and compression tests. Work on what is probably the most widely used structural alloy steel (3½ per cent nickel) is now in progress and will be followed by tests on other widely used types.

### Tensile Properties at High Temperatures.

There has recently been started, and is now under way, an investigation of the tensile properties of metals and alloys at high temperatures. The practical value of increasing our knowledge in this field can not be described in the limited space available. The first tests planned include determinations of tensile values (including elastic limit) on various grades of boiler plate from room temperature up to about 600° C., bearing on the value of the various grades with reference to interlocal strain in locomotive fire boxes. The results are also expected to throw further light on the relative value of two methods of melting used in the manufacture of such plates. Tests to throw further light on the effect of carbon and various alloying elements such as nickel, manganese, chromium, tungsten, etc., are included in the original scheme, these latter tests being made in cooperation with the Blue-Heat Committee of the Engineering Division of the National Research Council.

### High-Speed Steels.

A study of high-speed steels is being made to (1) throw further light on their constitution and properties; (2) to develop a simpler method than now in use for determining the relative value of two steels as cutting media. The methods now in use or contemplated include thermal analysis, whereby heating curves are taken on previously quenched samples, and hardness tests made after hardening and tempering at various temperatures. Cooperation from the mills is expected in this work. During the past year the problem of high-speed steel cutting has been at an acute stage, due to the extreme need for high-speed steel and to the shortage in the tungsten supply. This problem has been treated at the Bureau from the points of view (1) of the development of nonferrous cutting alloys, (2) the substitution of metals for tungsten, and (3) the improvement of high-speed steel forming practice; that is, cast versus wrought tool.

The Bureau has had the opportunity of carrying out tests on several types of product, including cast high-speed cutting tools which in test have shown cutting properties equal to the best wrought tools of similar composition. The extension on a large scale of the use of cast tools will work great labor and material saving and will result in lowering the cost of working metals. One of the special products studied has been cobalt-chrome tool steel, samples of which were submitted to elaborate tests and found inferior to the better grades of tungsten steel for high-speed tools. As a lathe tool it gave the best results when used for tools in which the cutting edge was not in continuous contact with the material being cut, as is the case with milling cutters. It can not be said that a satisfactory substitute for tungsten in such tools has yet been found. Besides these performance tests an investigation has been in progress on the general problem of the constitution and theory of the much-discussed high-speed steel and its " red " hardness. Data on several of the physical properties and microstructure of this steel, as affected by various heat treatments, have been collected, and seem to answer many of the questions involved.

### Gauge Steels.

An investigation of the most suitable steels and treatments for the manufacture of precision gauges, resulting from work originally carried on for the War Department, is now in progress. The work includes determination and comparison of resistance to wear, permanence, resistance to corrosion, soundness, expansibility, and economy under varying thermal treatments. It is expected that this investigation will be completed during the coming year.

### Metal Diaphragms.

Elastic lag and hysteresis are serious sources of error in the metal diaphragms and springs used in aeronautical instruments, such as altimeters and air-speed indicators. An investigation is now in progress to determine (1) the exact nature of these factors and (2) to develop diaphragms and springs which will minimize and possibly eliminate these effects.

Diaphragms and springs of various metals and alloys under varying thermal treatments have been, and are being, subjected to various types of loading in order to obtain a comparison of their elastic properties, and also to determine the best metal for such conditions of service, thereby improving the precision of these instruments. Material advance is expected during the coming year.

Of the numerous nonferrous alloys investigated the most promising for the construction of diaphragms is aluminum-bronze with 7 per cent aluminum content. A study is also being made of the hysteresis of steel springs and its elimination. The work done to date on elastic hysteresis leads to the probable conclusion that it is caused by overstrain. The theory has been developed in detail..

### Embrittling of Steel by Cleaning, Pickling, and Plating.

This investigation, which is now nearing a close, was started originally in connection with specifications for aircraft parts to determine the harmful effects of pickling, cleaning, and plating in wires, thin rods, and sheets of various grades of steel submitted to several heat treatments. Experiments with the tensile test as a criterion failed to measure properly the embrittling effect produced by pickling. The impact test on notched bars was also investigated, but it was found that no constant results could be obtained. Alternating-stress tests of 0.30 carbon steel show that pickling in sulphuric acid reduces the resistance to fatigue by more than 30 per cent for rods ranging in diameter from one-eighth to three-eighths of an inch. Steel rods three-sixteenths of an inch in diameter and carbon content varying from 0.09 to 0.87 per cent show somewhat corresponding reductions in resistance to fatigue. Analogous results were obtained by the Erichsen test on sheet steel of various thicknesses and hardness. Brittleness gradually decreases at room temperature, but recovery is not complete although hastened by heating. Brittleness caused by pickling appears to be the result of two effects combined: (1) A temporary effect supposedly dependent on hydrogen; (2) permanent effect caused by roughening or etching action of the acid. The effect of plating upon material which has been cleaned, pickled, or sand-blasted has also been studied.

### Temperature Measurements in Steel Works.

Opportunity was offered during investigation of steel-manufacturing processes, particularly with respect to uses of manganese, to measure the temperatures of various types of open-hearth and electric-furnace baths, and also tapping and teeming temperatures, in the practice of five steel companies. The results are particularly interesting, showing the remarkable uniformity of the refining temperatures for steel in the open hearth, both acid and basic. The electric furnace practice, in so far as temperature was concerned, was found not to differ materially from that of open-hearth practice. In the five plants examined the bath temperature was found to range in all cases between 1,590 and 1,640° C. Tapping temperatures ranged from 1,540 to 1,695° C., the higher value being for acid castings. Teeming temperatures ranged from 1,485 to 1,575° C.

## PHYSICAL PROPERTIES AND MISCELLANEOUS METALS.

### Tin Conservation.

Up to the time of the signing of the armistice the Bureau was actively engaged in studying methods of conserving tin. Experimental work was carried on in finding suitable solders, bearing metals, and bronzes containing a reduced amount of tin, and considerable correspondence was carried on with manufacturers and users of these materials. The Bureau also acted in an advisory capacity to the Bureau of Exports of the War Trade Board in matters concerning the use of tin, and also cooperated with the War Service Association of Manufacturers of Bearing Metals and Solders.

### Bearing Metals.

An extended program has been drawn up for an investigation of bearing metals. Although they are very widely used, there is little specific data in those works which treat of their properties and behavior, and no standard methods exist for their testing. The program will include physical tests at normal and elevated temperatures of all the commonly used bearing metals, together with actual tests under service conditions. It is doubtful whether much headway can be made during the coming year on the program, however, because of the lack of funds and facilities for carrying on the work.

### Corrosion of Brass Under Tension.

Twelve samples of drawn manganese-bronze rod have been exposed to atmospheric and water corrosion, while under known values of tensile stress, for a period of two years. The results to date are published in Technologic Paper No. 135, and show that, if this type of material is subjected to stresses at or above the proportional limit of elasticity, it may be expected to crack and fail in a relatively short time.

### Strength of Solder and Soldered Joints.

In connection with the American Society for Testing Materials tentative specifications for solder, it is thought advisable to determine the tensile strength of the various compositions of solders, and also of soldered joints of various metals with several different fluxes.

### Gold-Palladium Alloys as Substitutes for Platinum.

The high cost and scarcity of platinum greatly stimulated, especially during the war, the production of "platinum substitutes" for various purposes. Of those intended for use as chemical-laboratory ware no alloy of base metal so far tested has been found suitable. Two alloys of gold and palladium have been placed on the market and have come into more or less general use. These are known as "palau" and "rhotanium."

A series of tests has been carried out to determine the suitability of these alloys as substitutes for platinum in laboratory ware. The tests consisted of the determination of the behavior of crucibles made from the above alloys on heating to 1,100 and 1,200° C. in an oxidizing atmosphere and the effect of the various chemical reagents. The results of tests would indicate that in many instances these alloys could replace platinum very satisfactorily, thus releasing a large quantity of platinum for other purposes.

### Fusible-Tin Boiler Plugs and Tin Alloy.

To systematize the testing of fusible-tin boiler plugs, the Bureau has undertaken the study of the effect of small amounts of impurities on the melting point of pure tin. To this end alloys containing small amounts of copper, zinc, lead, and antimony, respectively, were made and their melting points determined. The results of the investigation would indicate that the first addition of all of the above metals lowers the melting point of tin, except in case of antimony, where the further addition of antimony above 0.1 per cent raises the melting point. The results obtained show that, in testing for purity, the simple melting-point test can be satisfactorily substituted for the laborious chemical tests at present used. The study of the effect of combination of impurities on the melting point of tin is at present in progress. The results of the first part of the investigation are in press and are to appear in an early number of the Bulletin of the American Institute of Mining and Metallurgical Engineers.

### Storage-Battery Grid Alloys.

Investigation of the properties of antimony-lead alloys for storage-battery grids is at present in progress. The physical properties, such as the melting point, tensile strength, brittleness, and hardness, are being determined on alloys containing from 3 to 25 per cent antimony.

### Acid-Resisting Alloys.

In spite of the success already attained with the use of acid-resisting irons in the chemical industries, there are still factors of difficulty to be overcome. The best alloys, so far as their acid-resisting properties are concerned, contain from 16 to 18 per cent silicon, are very brittle, and are so very hard that it is impossible to machine them in any other way than by grinding with high-speed abrasive wheels.

These points are decided drawbacks against their more general utilization, and experiments are under way at the Bureau to improve the physical properties of the metal and at the same time make it malleable and machinable.

### Effect of Degree of Reduction Upon Internal Stresses Set Up During Cold Rolling.

This investigation was undertaken with a view of trying to throw some light on the question raised as to the desirability of using many light drafts instead of a few heavy drafts in the drawing of brass condenser tubing and similar materials. The investigation showed the advantages of using many light drafts.

### Solidification of Steel Ingots.

In connection with the ingot research some experiments were carried out by means of paraffining wax ingots, made on a small laboratory scale, to determine the effect of rate of pouring and also the temperature of casting upon, (*a*) thickness of ingot walls formed during early stages of solidification, (*b*) height and location of pipe in entirely solidified ingot. The results of this investigation are being incorporated with other data in a paper for publication.

### Working of Metals.

Opportunity has been given in the past year to use the new metallurgical equipment for working of metals on several problems of military interest. It is planned to continue a series of investigations along systematic lines on the working of metals to determine for the various operations, and for metals and alloys including brasses and steels of various compositions the best temperature, the proper amount of reduction and the properties developed by this method of working, and the intercomparison, for example, of the metals which have undergone the operations of rolling, forging, and drawing.

### Treatment of Pure Nickel.

An endeavor has been made to make ingots of pure nickel without introducing contaminating gases. The metal is melted in a vacuum furnace, and attempts have been made to cold forge. It is essential to remove all oxides; otherwise the ingots will crumble.

### Light Aluminum Alloys.

The investigations carried out on light aluminum alloys, both wrought and cast, outlined in last year's report have been brought to a conclusion, and have either appeared in print or are in press. This work was done largely after consultation with the Light-Alloys Committee of the National Advisory Committee for Aeronautics, and includes an extended study of the heat treatment of duralumin; the mechanical properties and resistance to corrosion of rolled light alloys of aluminum and magnesium with copper, nickel, and manganese; the constitution and metallography of aluminum and its light alloys with copper and magnesium; and some tests of light aluminum cast alloys.

## RAILROAD MATERIALS.

The work on railroad materials has been resumed, and considerable progress has been made on several of the investigations, including the heating stresses developed in car wheels, discontinuities producing failure in rails, annealing practice as related to cast-iron wheels, investigation of ingot practice and of packing-ring iron for pistons.

### Graphitization of White Cast Iron.

An investigation has been completed on the graphitization of white cast iron upon annealing. This problem arose in connection with other investigations on the properties and characteristics of chilled-iron car wheels, and in particular the best range of annealing temperatures. This problem was brought to the attention of the Bureau by one of the car-wheel manufacturers. The composition is so chosen and the wheel is so cast that the tread and inside of flange show white iron and the remainder graphitized or gray iron. In order to relieve the stresses set up during the cooling of the wheel under drastic conditions, the wheels are piled in pits while red hot and allowed to cool very slowly. Investigation developed that the highest temperature at which no graphitization of the tread and flange takes place is about 720° C., which is also the maximum annealing temperature for car wheels. Incidentally, observations were made which contribute to the theory of graphitization in white iron.

### Investigation of Chilled-Iron Car-Wheel Stresses.

The investigation of stresses in chilled-iron car wheels caused by heat from brake action has been nearly completed. A very large percentage of car-wheel failures are attributed to stresses caused by heating of the tread by brake action, the central part or the hub of the wheel remaining relatively cool. It is the purpose of this investigation to determine and record for adoption the most suitable material and design of wheels to resist stresses of this kind. In this investigation the tread of the wheel is heated by passing an electric current through a circular resistor insulated from the tread. The wheel remains stationary, thus readily permitting the taking of the necessary temperature and strain-gauge readings. Considerable differences have been found in the behavior of wheels differing in design and weight. Several car-wheel manufacturers have cooperated with the Bureau, and it is expected that this investigation will be published shortly.

### Packing-Ring Investigation.

At the request of the United States Railroad Administration, the Bureau is continuing an investigation of the cast iron used in locomotive packing rings and similar parts subjected to the action of superheated steam by correlation of several mileage records furnished by the Railroad Administration, and the chemical, physical, and metallographic properties as determined by the Bureau. It is expected to gather sufficient information to formulate a specification for this important material.

### Ingot Investigation.

There is practically ready for publication an investigation carried out with the cooperation of one of the railroads and several of the steel companies involving a comparison of several types of ingot and ingot practice, including chemical, physical, and metallographic surface of the ingots, and of blooms and rails made from them. Of particular interest is the comparison of properties and segregation of rails made from ingots of the ordinary shape following three practices common in the United States, and the corresponding properties of rails made from ingots of the Hadfield type with sink head. This investigation, which will be published soon, will include chemical analysis of split ingots, split rails and blooms, sulphur prints, metallographic investigation, tensile, hardness, and drop tests.

### Effect of Sulphur and Phosphorus in Steel for Railroad Materials.

During the war it was found practically necessary to permit the use of steel for railroad and other materials containing higher amounts than was considered desirable of the detrimental elements, sulphur and phosphorus. At the request of the Railroad Administration, the Bureau is outlining an investigation of sulphur and phosphorus and the permissible maximum for the various classes of steel. The question has been under discussion for some time, and it appears that the specification-making organizations, such as the American Society for Testing Materials, are lacking in sufficiently exact scientific knowledge to determine in rational terms the fixed limits of these elements in steels for various purposes. This investigation will be carried out in part with the new equipment now possessed by the Bureau and in part with material submitted by steel manufacturers and the railroads. Some work has also been done on the effect produced by varying the amount of phosphorus upon the microstructure and hardness of a low-carbon steel (basic open hearth and acid open hearth 0.12 per cent carbon and from 0.008 to 0.115 per cent phosphorus). They had been cooled down through the range 750 to 600° C. at different rates varying from 5 minutes to 4 hours, the steel first being heated to 900° C. in all cases.

## CHEMICAL METALLURGY.

The work of the section of chemical metallurgy during the past year (and previous years) has been concerned mainly with the small-scale production of pure metals and alloys made therefrom. Physical properties of these alloys and metals are studied in other sections of the Bureau. Such activities have necessitated many auxiliary investigations. Among these might be mentioned researches in progress on methods for determining the gases contained in steel. It has been known in a general way for a long time that commercial steels contain appreciable amounts of nitrogen, hydrogen, and carbon monoxide, and these gases are believed to have important effects on the breaking strength and other properties of the metal. Such questions can not properly be studied until reliable methods are available for determining such gaseous impurities and until steels can be made free from such gases or containing known amounts of them. Accordingly the pure metals and alloys are being melted in vacuum furnaces, so that the products obtained are practically gas free. If desired, varying amounts of any desired gas can then be introduced into the metal and the effect studied. Another method for removing gases, or undesirable effects of gases, consists in adding to the molten metal some other metal or alloy which combines with the gases and renders them harmless, or else removes them. Such alloys are called "deoxidizers," and the processes involving their use are called "deoxidation"; such processes are a vital part of all commercial methods of making steel. The study of deoxidation and the use of new deoxidizing alloys has formed part of the working program of the section of chemical metallurgy.

In many cases, unless alloys are made under proper conditions, they are not uniform in composition throughout, and are then called "segregated." Such "segregated" portions are discovered by analyses of portions of the nonuniform metal taken in some systematic way. Many segregation studies of this type have been conducted in the section, especially on alloys containing carbon and manganese. To reduce the time required for such routine determinations, a new method was devised for determining carbon; this method not only is shorter than others in general use, but is more accurate.

Much of this work has been of importance from a military point of view, particularly those phases of deoxidation studies having as one of their objects the conservation of manganese in the steel industry.

The standardization of practice in methods of chemical analysis in the steel industry and of the shape of test pieces used for securing drillings for such analyses has also occupied the attention of the section.

The activities in these various groups of work, as well as in some others, are described in detail in the subsequent sections of this report.

**Alloys and Pure Metals.**

The equipment for making electrolytic iron, and melts or alloys of it by vacuum melting, has been doubled in capacity. A method has been developed for making pure magnesium oxide by calcining pure magnesium sulphate at 1,100° for long periods. This method produces magnesium oxide at much lower cost than by the acetate method previously used. Large quantities of this purified material are required to make the crucibles used in producing ingots of pure metals and alloys. A considerable number of ingots of pure iron and alloys, principally the manganese-iron-carbon alloys, have been produced during the year. A thorough segregation study of these alloys has been made, and some use has been made of the Brinell hardness machine in exploring segregation.

**Pure Aluminum.**

The apparatus described in last year's report has been used, but it has been found simpler to supply electrically the heat for maintaining the bath in a molten condition. Due to the extreme fluidity of the molten cryolite, which causes it to leak from threaded or other joints in the graphite, the design of a suitable container that will permit the metal to be tapped is much complicated.

**Tests of Phillips' Alloy.**

A ferrous alloy called "Phillips' alloy" was submitted to the Bureau by a firm in Attleboro, Mass., which made the alloy from ore obtained locally. It was claimed that this alloy imparted valuable properties to steel. The Bureau made several pounds of the alloy from the ore and had it added to Tropena's converter steel at the Naval Gun Factory. None of the remarkable properties claimed were found in the steel so made.

### Method for Determining Gases in Steel.

The electric furnace described in the previous report has been tested and found not entirely satisfactory. Electric furnaces with pure iron, nichrome, and platinum resistors operating in vacuo have also been tried. Some successful determinations have been made using the latter furnace, and it is believed that the furnaces with carbon, nichrome, or iron resistors will be developed to work satisfactorily. A Northrup-Ajax high-frequency induction furnace is now being tested as to suitability for this work.

### Determination of Individual Gases.

Methods for determining oxygen—that is, oxides—nitrogen, and carbon monoxide have been especially studied. The direct determination of nitrogen (by absorption with calcium vapors as calcium nitride and determination of the ammonia formed by hydrolysis of this compound) has been further tested with good results. The apparatus necessary for the determination has been still further simplified. The determination of carbon monoxide by fractional combustion methods, using such catalyzers as copper oxide, cobalt oxide, nickel oxide, etc., has given good results, and work on specific absorbing agents for carbon monoxide is now in progress. Three papers dealing with the Ledebur method for determining oxygen in steel have been completed. Technologic Paper No. 118 is a critical study of the method, and shows that it can determine only a few of the many oxides liable to be present in steel and that such determinations require such unusual care and skill as to render the method of doubtful value. A scientific paper now in press deals with certain fundamental sources of error in the Ledebur method and shows that probably not over 75 per cent of the determinable oxides are given by this method. A technologic paper now in press details work in which an attempt was made to determine by the Ledebur method the oxygen content of steels deoxidized in various ways, but no differentiation according to method of deoxidation could be made.

In view of these researches it is believed that the Ledebur method is of little value to metallurgists.

Another method which was found to be without practical value was the Gontal method for determining carbon monoxide and dioxide in steels. The fundamental defects of this method mentioned in a previous annual report (1917) have been confirmed by later work, which is described in Technologic Paper No. 126.

### Conservation of Manganese.

Two lines of research initiated during the war are being carried on with a view to economizing in the use of manganese in steel manufacture:

(1) A series of alloys of iron, carbon, and manganese, using pure materials, is being made, and these alloys are to be tested for physical properties in the heat-treated and annealed condition. With these data it is hoped that revisions in specifications for certain steels can be made whereby their residual manganese content can be much decreased.

(2) An investigation is being carried on in cooperation with the National Research Council and others whereby substitute deoxidizers

such as various combinations of the deoxidizing elements of silicon, aluminum, titanium, and manganese, will be tried for making steel. The steel so made will be rolled and forged in the Bureau's plant and then tested for physical and other properties. A small open-hearth furnace of 500 pounds capacity has been designed and built for this purpose.

### Electrolytic Carbon Method.

The Bureau's paper describing this method appears as a technologic paper, and it will also be published in the Journal of Industrial and Engineering Chemistry for September, 1919.

### Ladle-Test Ingot Investigation.

The report on this work has been published as an appendix to the Report of Committee A–1 of the American Society for Testing Materials. Arrangements are in progress to continue the work which was interrupted by the war.

### Alloy Work.

It is hoped still further to improve the technique of making pure iron or alloy melts in the following ways: (1) By making crucibles by the extrusion process instead of pressing into molds, as now practiced; (2) by melting 25 to 50 pounds of electrolytic iron at a time and forging this to 1½-inch bars, which will then be cut into suitable lengths and used as charging material for small crucibles used in the Arsem furnace; (3) by continuous operation of both Arsem furnaces as soon as another heavy current line is installed; (4) by use of the Ajax-Northrup high-frequency furnace; (5) by operation of more electrolytic baths for making iron; (6) by attempting to drop-forge test bars to shape instead of machining them.

### Work on Gases in Metals.

It is believed, as soon as the Ajax-Northrup furnace is operating satisfactorily, that very substantial progress will be made. It is also intended to perfect the design of the resistor furnaces which have already given some results.

### Work on Investigating the Deoxidation of Steel.

As soon as the small open-hearth furnance is installed it will be used to melt heats of steel which will be deoxidized with some of the old deoxidation processes, and also with some of the new deoxidizers developed during the cooperative investigation with the National Research Council. Such steels are intended to be tested for rolling and forging properties, gas content before, after, and during deoxidation, and for the usual physical properties.

### Production of Pure Aluminum.

Some experiments will be made in the endeavor further to purify commercially pure aluminum by melting it under fluxes of various kinds. Electrolytic experiements with chemical control of bath composition will be continued.

## FOUNDRY.

The Bureau's foundry performs two functions, (1) foundry research and preparation of metals and alloys for the investigations of the metallurgical division, and (2) serves as a commercial foundry supplying castings mostly for instrument parts to the Bureau and other Government laboratories. The time of the foundry staff is about equally divided between these two functions. This foundry appears to be about the only experimental one conducted by the Government and is one of the very few experimental foundries in the country. It serves a vast industry, and its possibilities for growth and service are very large. It is hoped that, in the near future, it will be possible to increase both the equipment and personnel to a point where it will be possible to undertake the investigation of many of the more urgent foundry problems.

**Government Bronze and Its Substitutes.**

In extension of the cooperative work of the Bureau of Standards with the committee on nonferrous alloys there were made up under identical conditions in five foundries a series of test bars of Government bronze (88 Cu, 10Sn, 2Zn) which were then tested at the Bureau of Standards. A previous five-foundry set of tests of this type of metal had shown very considerable discrepancies, evidently caused by differences in test bars and other variations from standard practice. In the second series care was taken to reproduce as nearly as possible identical conditions of operation in each foundry, and an improved test bar was used. The results for two compositions were as follows:

| Number of specimens. | Proportional limit. | Tensile strength. | Elongation in 2 inches. | Reduction in area. |
|---|---|---|---|---|
| | | *Pounds per square inch.* | *Per cent.* | *Per cent.* |
| 88 Cu, 10 Sn, 4 Zn | 12,200 | 38,900 | 25.3 | 21.0 |
| 5 foundries, 30 | ±1,600 | ±5,250 | ±5.9 | ±4.7 |
| 88 Cu, 8 Sn, 4 Zn | 11,000 | 39,400 | 32.0 | 25.0 |
| 5 foundries, 26 | ±1,650 | ±4,200 | ±7.0 | ±4.6 |

At the request of the Navy Department additional investigations have been made of other modifications of the above type of bronze. Of nine variations in composition of lead, zinc, casting bronzes containing 90 per cent Cu, the most satisfactory had the composition of 90 Cu, 6½ tin, 0.5 lead, and 3 zinc. This composition has a proportional limit of 12,200±650 pounds per square inch, tensile strength of 40,700±1,500 pounds per square inch, elongation in 2 inches of 37.6±6.4 per cent, and reduction in area of 34.1±4.5 per cent. Substitution of lead above one-half per cent for zinc or tin and of zinc above 2 per cent for tin was found to have detrimental effects on the physical properties of the castings. Further work on this series of bronzes is being continued, and it is expected to be able definitely to map the system of bronzes containing copper, tin, lead, and zinc over the range of practical interest.

**New Melting Equipment.**

The metal-melting equipment of the Bureau has been augmented during the past year by the putting into operation of an electric-arc furnace of a modified Herault type, of 600-pound capacity, for melting steel and iron, and by the construction of an electric crucible furnace for melting steel and other alloys, and a small hearth furnace for melting cast iron. The foundry is now in a position to melt any metals or alloys used in the making of castings.

### Weathering of Art Bronzes.

A study is being made of the relation of the composition of statuary bronzes to the facilities with which they assume patinas on exposure to weather. A series of such bronzes has been subject to exposure tests for some three years. This work is being carried out with the cooperation of one of the statuary manufacturers and with the advice of distinguished sculptors.

### Efficiency Study of Electric Furnaces.

The Bureau has made an efficiency study of one type of electric melting furnace and has made suggestions for the improvement of several types of electric metal-melting furnaces. This work will be carried further, since melting of metals by electricity has become an important factor in the foundry industry.

### Several Types of Metallurgical Refractories.

The possession of a number of types of metal-melting furnaces heated by a variety of fuels, gas, oil, and electricity enables the Bureau to collect data on the action in actual service of different metallurgical refractories under various conditions of heating; the metallurgical and ceramic divisions cooperate in this work, the results of which, it is expected, will lead to a more thorough understanding of the properties and adaptability of existing metallurgical refractories and to the development of new ones.

### Protective Coatings for Aluminum Castings.

At the request of the Bureau of Aircraft Production of the Army an investigation of various protective coatings to prevent corrosion of aluminum castings is being continued. After a satisfactory coating can be found it will have considerable value for industrial uses also.

### Experimental and Practical Castings.

The past year has seen a marked increase in service given by the foundry to the Bureau and the research laboratories of other Government departments in the preparation of a great variety of kinds and types of metal and alloy castings. The value of castings furnished to laboratories was $1,850. Following is a tabulation of the salient points of this service:

| Metal. | Castings. | Patterns. | Weight |
|---|---|---|---|
| | | | *Kilograms.* |
| Bronze | 684 | 93 | 648 |
| Brass | 1,738 | 417 | 1,896 |
| Al alloy (light) | 432 | 169 | 554 |
| Al bronze | 58 | 2 | 23 |
| Cast iron | 68 | 16 | 240 |
| Lead | 5 | 4 | 381 |
| Pb–Sb alloy | 1 | 1 | 10 |
| Copper | 6 | 1 | 7 |
| Mirror metal | 1 | 1 | 9 |
| German silver | 8 | 1 | 1 |
| Total, 1919 | 3,001 | 705 | 3,769 |
| Total, 1918 | 2,249 | 516 | 2,455 |

### Investigation of Light Aluminum Casting Alloys.

This type of alloy is of great interest in the airplane and automobile industries, and the object of this investigation was to discover alloys with improved mechanical properties, the effects of heat treatment, impurities, foundry practice, and their corrodibility. The tensile properties and hardness of a number of light aluminum-casting alloys have been determined, resistance to corrosion compared, and resistance to alternating stresses determined of a few commonly used compositions. It is possible to obtain an alloy containing from 2 to 3 per cent copper, together with 1 or 2 per cent nickel or manganese, or both, which will have a reasonable amount of ductility, and it is believed that an alloy of this type should have commercial value. Mechanical properties suggested for such an alloy are the following: Tensile stress, 22,000 to 25,000 pounds per square inch; elongation, in 2 inches, not less than 5 per cent. The addition of manganese to alloys containing copper reduces, in a marked manner, the ductility, but increases the tensile strength and the hardness. Annealing at 500° C., followed by several days' aging, increases the tensile strength and hardness and generally decreases the ductility. Magnesium appears to increase the hardening effect of heat treatment. The heat treatment of light aluminum castings would seem to have commercial possibilities. The salt-spray corrosion test showed no very appreciable difference between the several compositions in resistance to corrosion. A study of the resistance to the action of alternating stresses of three compositions of light alloys containing, respectively, (1) 8 per cent copper; (2) 12 to 15 per cent zinc, 2 to 3 per cent copper; (3) 1 to 2 per cent copper, 1½ to 2 per cent manganese, showed very little difference, all withstanding 10,000,000 complete reversals at the maximum fiber stress of 7,000 pounds per square inch.

**Molding-Sand Investigations.**

Methods have been developed for testing sands and clays to determine their fitness for various uses in foundries. In addition to the testing of a large number of molding sands and clays by accepted methods, this work has involved the development of new forms of apparatus for determining the permeability and the cohesiveness of sands and for ascertaining the proper amount of water to use with a given sand. A new and important feature of this investigation is the testing of sands after converting them, by baking, to approximately the condition of sands being used for making castings. These tests are more instructive than tests conducted on sands fresh from the quarry, as has been the custom hitherto.

Considerable work has been done in connection with the recovery of sand from the waste-sand heaps of steel-casting foundries. Tests have shown that it is possible to reclaim for further use a large proportion of the sands now being discarded.

A bulletin on the methods of testing sands and on the recovery of usable sand from what is now considered waste material is now being prepared.

**New Type of Volumeter.**

A new type of volumeter for accurately measuring the volume of bodies of irregular shape (such as sand, etc.) has been devised and its limits of accuracy derived. The principle of the apparatus is the displacement of a liquid upon immersion of the solid and the measurement of the amount of liquid displaced by noting the rise of liquid in a long slanting tube of small bore. The advantage of this apparatus is that it is very rapid in operation and measures volumes to 0.01 cubic centimeter, while the accuracy obtainable with other types of displacement volumeters is limited by the size of one drop of the liquid used, approximately 0.05 cubic centimeter. This apparatus has many possible applications in testing and research work.

## 9. CERAMICS.

[Development of new uses for clays; replacement of imported by native materials; improvement of quality of products; designing and conducting tests for quality; standards of quality; routine tests for Government purchases; acting in advisory capacity as to conservation of fuel and transportation for ceramics; acting as clearing house for collection and dissemination of information.]

### CLAY PRODUCTS.

(Investigation of building tile and other clay products; industrial and educational cooperation; design of new equipment; development of enamels for iron and copper; studies of kiln efficiency; new uses for clay products; improvement of quality of products; manufacture of certain porcelains for Government use.)

### Standardized Clay Tests.

Considerable work has been done during the past year in cooperation with the committee on standards of the American Ceramics Society in its endeavor to establish uniform methods for the testing of clays. Check determinations have been made and several devices designed for use in this connection.

### Refractories.

The general subject of refractories has received continued attention. Definitions covering the general requirements of clay refractories have been proposed and adopted as tentative specifications by the American Society for Testing Materials. Work is in progress on a modified method of determining the softening point of refractory materials.

Tests involving the estimation of the softening point, resistance to load, and the chemical composition have been made throughout the year for the Panama Canal, several navy yards, and other departments of the Government.

Two technologic papers dealing with the subject of silica refractories have been published.

Considerable work has been done in cooperation with three manufacturers dealing with the development of improved blocks for glass-melting tank furnaces. The importance of this subject justifies vigorous effort. The results so far obtained are encouraging and indicate that the study has been pursued on sound principles, but trials on a large scale are required to verify the facts so far ascertained.

A very satisfactory white furnace cement to be applied upon the exterior of furnace walls or to be used as a mortar has been developed.

### Light-Weight Refractories.

The new type of refractory proposed by the Bureau last year, combining light weight, porosity, good heat-insulating quality, and high refractoriness, has aroused considerable attention, with the result that several companies have undertaken its manufacture. There is every reason to believe that this type of material will find application in connection with marine-boiler installations, furnace crowns, kiln blocks for terra cotta, and other wares.

### Refractory Porcelain.

Further progress has been made in the production of the heat-resisting material known as Marquardt porcelain, formerly imported from Germany, and it has been found possible to produce pyrometer tubes over 7 feet in length. A technologic paper on this subject is in course of preparation, and a similar contribution has been submitted to the American Institute of Mining Engineers to be read at the September meeting, 1919. Assistance has been rendered to three plants engaged in the manufacture of Marquardt porcelain. The necessity of firing to a temperature of not less than cone 16, and preferably 18, has been pointed out.

### Sillimanite Refractories.

Tubes and other shapes of commercially pure sillimanite ($Al_2O_3.SiO_2$) composed of 102 parts of anhydrous alumina and 258 parts of kaolin have been made and have proved satisfactory.

### American Crucible and Glass-Pot Clays.

A technologic paper dealing with this subject has been submitted for printing. It comprises a careful study of the physical properties of a number of high-grade domestic clays compared with two well-known German clays. At the same time the principles involved in the construction of crucible and pot bodies are discussed.

### Porcelain Glass Pots.

The porcelain and semiporcelain pots worked out for the melting of optical glass have been thoroughly tested out in several hundred melts and have proved very successful. The best porcelain composition has been found to be as follows:

| | Per cent. |
|---|---|
| White-ware bisque, through 10-mesh sieve | 48 |
| Tennessee and Kentucky ball clays | 23 |
| Kaolin | 24 |
| Feldspar | 5 |
| Total | 100 |

The white-ware bisque is waste material from earthenware and wall-tile plants.

### Casting Process.

The process of casting glass pots and other heavy clay products has been steadily improved and has been extended to the making of closed pots. Further developments are under way in cooperation with two manufacturing establishments.

### Study of Spark-Plug Porcelains.

The results of a large number of experiments with 195 porcelain compositions have been analyzed and described in Report No. 23, Aeronautic Power Plants. Similar reports will be published as a Bureau publication and in the Journal of the American Ceramic Society.

One of the best porcelains, showing high electrical resistance at a temperature of 690° C. and good mechanical qualities, has the following composition:

| | Per cent. | | Per cent. |
|---|---|---|---|
| Georgia kaolin | 10 | Calcine No. 19 | 40 |
| Florida kaolin | 10 | Calcine No. 14 | 20 |
| North Carolina kaolin | 10 | Delaware kaolin | 10 |

The compositions of the calcines are:

| | Calcine No. 14. | Calcine No. 19. |
|---|---|---|
| | *Per cent.* | *Per cent.* |
| Kaolin | 56.00 | 70.20 |
| Anhydrous alumina | ... | 27.80 |
| Magnesium carbonate | 18.20 | ... |
| Potters flint | 25.80 | ... |
| Boric acid | ... | 2.00 |

The minimum maturing temperature of this porcelain corresponds to cone No. 16, or approximately 1,450° C. The calcines Nos. 14 and 19 require 1,390 and 1,530° C., respectively, for proper calcination.

The use of this type of porcelain is being extended to products other than spark plugs, where high electrical resistance at elevated temperatures is required, such as heating devices, insulators for the Cottrell process, etc.

### Use of American Clays in White-Ware Pottery.

The cooperative work conducted with the United States Potters' Association in 11 plants at East Liverpool, Ohio, has been completed. The object of the investigation was to make pottery entirely from American clays under commercial conditions. It has been shown that tableware of excellent quality can be made from domestic materials. Of the 46 compositions more than one-half proved to be satisfactory.

### Terra-Cotta Bodies and Clays.

An exhaustive study of practically all clays and prepared mixtures used in the manufacture of architectural terra cotta is under way and is rapidly approaching completion. The work embraces the study of the porosity and volume changes shown by the materials at different firing temperatures, their mechanical strength as estimated by the transverse test, and their resistance to the disrupting action of crystallizing sodium sulphate. In this manner it is expected to establish the minimum temperatures to which the materials must be fired in order to possess the required strength. At the same time, the peculiarities of the clays and bodies from different parts of the country will be set forth.

### Hard-Fire Porcelain.

The elaborate investigation of hard-fire porcelain begun three years ago is approaching completion. More than 300 compositions have been studied with reference to porosity and volume changes at different temperatures, the points of vitrification and overfiring, mechanical strength, tendency to deform, coefficient of expansion, and other physical constants. Several thousand pieces of tableware, plates, cups, and saucers have been glazed and fired. It is believed that this work will shed much light upon aspects of hard-fire porcelain manufacture which have been overlooked, and will contribute toward placing our knowledge of this subject on a firmer basis.

Several one-fire porcelain compositions have been developed with a pleasing glaze which have been applied successfully in several potteries.

Cooperative work has been done also in connection with the manufacture of hard-fire porcelain for use in the textile industry.

### Clay Tests.

Approximately 300 tests of clays, fire bricks, feldspar, flint, whiting, and other ceramic materials have been made for Government departments and the public.

### Scientific and Industrial Cooperation.

Cooperation is being maintained by the Bureau with many firms and individuals with reference to industrial problems, both by correspondence and consultation.

A large amount of work is being done also in cooperation with the scientific branches of the Government, the National Research Council, the American Ceramics Society, the National Terra Cotta Society, the United States Potters' Association, the Refractories Manufacturers' Association, the American Society for Testing Materials, the National Brick Manufacturers' Association, etc.

### Equipment of Ceramics Division in Industrial Laboratory.

The contracts for the construction of new furnaces and kilns have been let, all of the machinery and apparatus purchased, and the installation of the equipment begun.

### Enameled-Metal Products.

A section devoted to this branch of industry has been formally organized and has begun its activities in a vigorous manner. Two technologic papers dealing with the principles of iron enameling are being printed. The researches under way are concerned with difficulties encountered in the manufacture of enameled cast iron and steel products.

Several enamels adapted for application on copper have been worked out, which replace similar compositions formerly imported from Germany.

### Zircite Refractories.

Fire bricks made from zircite ore cemented by means of ball clay have been made for the Washington Navy Yard.

### Zinc Spinel.

A study has been made of the proper temperatures required to calcine mixtures of zinc oxide and alumina to form crystalline $ZnO.Al_2O_3$, which is used as an opacifier in enamels and glazes, replacing the expensive tin oxide. Likewise, the use of different sources of zinc oxide and alumina, such as zinc carbonate and hydrated alumina, were investigated.

### Tennessee Ball Clays.

The effect of washing Tennessee ball clay, represented by 15 samples, has been studied by determining the residue left on the lawn, the volume shrinkage, and the strength of the dried clay, the color and shrinkage of the fired material. The purpose of this work was to show whether refining of the material by washing is justified.

### Investigation of Brick Piers.

The complete data of this investigation, covering the discussion of the results of tests on 50 piers 2½ by 2½ by 10 feet high, has been published since the last report. The demand for this report has been so extensive that it has been necessary to issue a second edition. An abstract of this investigation was presented in the last report.

### Investigation of Strength of Hollow-Tile Walls.

*Material Used.*—The tiles used in the construction of the walls were furnished through the courtesy of the National Fireproofing Co. The results of determinations of the physical properties of the tile have already been published in Technologic Paper No. 120, the specimens being from an Ohio plant. The data obtained were chiefly the compressive strengths and absorption properties. About 250 tests were made. The strength, moduli, and hardness results were correlated with the results of absorption tests. It was found that the strength of the tile, when tested on ends, averaged about 7,500 pounds per square inch of net cross-sectional area, with a variation from 4,500 to 12,000 pounds per square inch between the minimum and maximum results obtained for the series. The compressive strengths and moduli of elasticity varied approximately inversely with the capacity to absorb water. The absorption varied from 4.4 to 10.9 per cent, with an average of 8 per cent. Through the joint cooperation of committee C–10 of the American Society for Testing Materials similar tests were conducted by various laboratories with different geological locations. The ceramic properties of the clay influence the behavior of the finished product and depend on the location. Through the correlation of the results with those of the other laboratories—all data being selected in accordance with the same general program—it is believed important information has been furnished for writing building-codes specifications as regards this commodity.

*Description of Walls Tested.*—There were 32 walls constructed for test purposes according to the following specifications: The walls were 4 feet wide by 12 feet high and thicknesses of 6, 8, and 12 inches, depending on the dimensions of the tile. The tile for 24 of the walls were selected from an Ohio plant and those for the remaining walls from the Perth Amboy (N. J.) plant of the National Fireproofing Co. The compressive strengths of the walls were determined with the flues running vertically in one series of tests, in another with the flues running horizontally, the load being applied concentrically with the axis of the 10,000,000-pound testing machine. Similar tests were carried out to determine the effects of applying the load eccentrically to approximate the behavior of joists and floor loads. Further tests also were conducted on the strength and absorption of the individual tiles.

The results obtained are, in brief, as follows: The average loads for the 6, 8, and 12 inch walls of Ohio tile, flues vertical, under concentric loading, were 297, 408, and 543 in thousand-pound units, respectively, and about half these values when the flues were placed horizontally. The Perth Amboy 6 and 12 inch walls withstood much lower average values—that is, 137 and 241 in thousand-pound units, respectively—when flues were vertical and 42 and 70 in thousand-pound units when horizontal.

There was a marked reduction in the strength of the walls as a result of eccentric loading, and in several cases the failures were local at point of loading, in which case the walls were retested under concentric loads, as before.

It was originally the intention to carry out the tests in accordance with the program covering geographical districts, so as to be representative of the entire national output. War conditions made this impossible on account of the lack of transportation facilities. But, since there are now numerous results of tests of tile from different districts tested in concert, it may be assumed that the ratio of the strengths of single tiles to those of walls will be proportionately the same in the various districts as has been found for Ohio and New Jersey.

All the tests have been completed, and the results are being prepared for early publication.

### Architectural Terra Cotta.

The study of the properties of this material has been continued during the year with very gratifying results. More attention was paid to the examination of the material in service on buildings for various periods of time. Two very striking types of failures were encountered, both due to lack of knowledge of the proper use of terra cotta. The first type is that where the glaze is forced away from the body. This is apparently due to improper protection of the unglazed portions from contact with moisture, such as "backing up" free standing work with soft brick, or lack of flashing or waterproofing edges or joints of this type of work. The second type is due to improper methods of attaching the terra cotta veneer to the structure and is shown by actual crushing of the terra cotta. These examinations force one to the conclusion that too many failures are due to a lack of proper knowledge of the use of otherwise satisfactory materials. This applies to other veneers, especially stone, which is used so much on the exterior of lower floors of structures. Both granite and limestone were found which had failed either in compression or shear.

The laboratory part of the work consisted in making test pieces for absorption, artificial freezing, and transverse-strength determinations from the various clays and bodies used by the majority of the manufacturers of the country. These test pieces were burned at seven different temperatures. With the collation of the data obtained from these, a final report will be prepared during the coming year, covering all the work done by the Bureau on this interesting and valuable decorative material.

### Fire Tests of Concrete Columns.

In this investigation, 28 full-sized building columns of reinforced concrete have been made, 25 have been subjected to the combined fire-and-load test, and 7 have been tested cold, in compression, in the 10,000,000-pound testing machine. A complete description of this work will be found in the report of division 3.

### Determination of Laws of Earth Resistance.

This research was inaugurated in cooperation with the soils committee of the American Society of Civil Engineers and has been briefly discussed in the last report. The matter has already been given considerable attention by the Bureau in the field of electrolysis mitigation and the related problems in soil resistivity. The present investigation has dealt entirely with the corresponding problems involving the laws of mechanical resistance to strain as a result of the presence of engineering structures in earths—piers, foundations, piles, retaining walls, etc. It has been the aim to ascertain the laws which condition or control engineering practice and to give the proper dynamical interpretation of these laws in accordance with the accepted principles of physics. It has been found experimentally that the behaviors of soils are conditioned by their structures. This fact has largely been ignored in soil analyses. It is therefore necessary to conduct fundamental investigations to determine these structures and the laws of transmission of matter, energy, momenta, stress, or other entities as influenced by them. The cooperating committees have given attention primarily to the classification of soils, the proper hypothecation of structures in conformity with statistical mechanics, the devising of apparatus for field and laboratory measurements, and the conducting of individual tests to determine the actual properties and behaviors of a great variety of soils. It has been found thus far that the problem of soil behaviors admits of a complete scientific statement and direct correlation with other physical science. In several cases the mechanical behaviors have been found to correspond very closely to analogous results found in the related problems in the various branches of physics. In other cases the predictions and contentions of scientific investigators as to the impracticability and irrationality of the older theory of earth resistance, as previously formulated, are sustained by experiments.

On account of the surmounting of certain mechanical difficulties which have been encountered from time to time in experiments and the labor involved in the dynamical interpretation of the various data it has been impossible to complete the final report at this time. Several reports have been published by the soils committee of the American Society of Civil Engineers, which contain the results of the preliminary and earlier experiments made by the Bureau. The final report on the investigation is being prepared for publication.

### General Tests of Structural Materials.

The following tests not classified in reports of researches have been made for various departments of the Government and different manufacturers. These include 57 tensile tests of wire ropes ranging in diameters from three-eighths to 1½ inches, including the preparation of most of the specimens for tests, for use by the Government at the Isthmian Canal; 34 tests of Manila rope ranging in diameters from three-fourths to 4 inches; 1 test of a steel hoisting sling for derricks; 4 tensile tests of sheet aluminum; 4 determinations of the elasticity of special spring steel; and 8 tests of sand-lime brick for compression and bending.

A number of tests were conducted for the underwriter's laboratory, as follows: Determination of the compressive strength of 3 reinforced-concrete columns and 9 timber columns, including moisture percentages; 20 bricks and 100 building tile tested transversely to ascertain the flexural strength.

The following tests were made for different departments of the Bureau of Standards: (1) For the cement section: Four hundred and forty-four transverse tests of 1-inch square bars of sorel-cement flooring material 11 inches long; 297 compressive-strength tests of 6-inch concrete cylinders 12 inches long; 980 similar tests of 2 by 4 inch cylinders of sorel cement; 385 compression tests of 2 by 2 inch cubes of cement. (2) For the fireproofing section: Seven concrete columns 12 to 18 inches in diameter by 9 feet for compressive strength; 133 cement cylinders in compression; 102 cylinders of concrete 6 inches in diameter by 12 inches; tensile tests of 9 steel reinforcing bars. (3) For the ceramic section: Eighty-seven porcelain cylinders 1¼ inches in diameter and 36 1-inch porcelain cubes for compressive strength; 19 transverse tests of clay briquettes and 25 of brick. (4) For the lime section: Fifty-four tests of 2-inch lime cubes and 50 tests of 6 by 12 inch cylinders both in compression.

Inspections of reinforcing steel for the Bennings viaduct were conducted at various steel mills for the Commissioners of the District of Columbia by this department.

STATEMENT SHOWING NUMBER AND VALUE OF TESTS AT THE (PITTSBURGH LABORATORY) BUREAU OF STANDARDS. FISCAL YEAR 1918–19.

| | For Government. | | For public. | | Total. | |
|---|---|---|---|---|---|---|
| | Number. | Value. | Number. | Value. | Number. | Value. |
| Cement | 2,804 | $7,924.00 | | | 2,804 | $7,924.00 |
| Clay products [a] | 61 | 673.00 | | | 61 | 673.00 |
| Miscellaneous | 122 | 936.00 | 47 | $155 | 169 | 1,091.00 |
| Chemical | 585 | 2,073.50 | 1 | 10 | 586 | 2,083.50 |
| Total | 3,572 | 11,606.50 | 48 | 165 | 3,620 | 11,771.50 |

[a] In addition to the above, preliminary tests on samples of clay, for which no fee is charged, were made on 39 samples.

## GLASS.

(Examination of raw materials for glass and for glass pots; development of improved methods for making glass pots; design of plant for manufacture of glass pots on large scale; manufacture of a particular quality of optical glass on large scale for Government use.)

Steady progress has been made in the development of optical-glass manufacture at the Pittsburgh laboratory. New procedures in molding, such as gathering direct from the pot and softening the glass in the glory hole were tried out. The results of the investigations on annealing conducted at the Washington laboratory were applied in the Pittsburgh plant. The melting schedules have been more and more standardized.

The indices of refraction, the dispersion value, the percentage light transmission, the oxide composition, and the batch mixtures of the optical glasses made at the Pittsburgh laboratory are given in the following tables:

OPTICAL PROPERTIES OF GLASSES MADE BY THE BUREAU OF STANDARDS.

| Kind. | $N_d$. | $N_c$. | $N_f$. | $N_g$. | V. | T. |
|---|---|---|---|---|---|---|
| Light flint | 1.582 | 1.578 | 1.592 | [a]1.600 | 43.6 | 99.7 |
| Medium flint | 1.624 | 1.618 | 1.635 | 1.645 | 37.0 | 98.5 |
| Dense flint | 1.648 | 1.643 | 1.661 | 1.673 | 35.0 | 99.1 |
| Light crown | 1.518 | 1.515 | 1.523 | 1.528 | 59.8 | 98.8 |
| Barium crown | 1.570 | 1.567 | 1.577 | 1.590 | 58.2 | 99.0 |
| Dense barium crown | 1.610 | 1.607 | 1.618 | 1.630 | 56.0 | 96.0 |
| Borosilicate | 1.516 | 1.514 | 1.522 | 1.527 | 61.6 | 97.8 |
| Barium flint | 1.550 | 1.548 | 1.560 | 1.565 | 52.0 | 99.5 |

[a] $N_g$1, $N_d$, $N_c$, $N_f$, $N_g$=indices of refraction for D, C, F, G lines, respectively, of the spectrum. V=dispersion; T=transmission.

## COMPOSITION OF GLASSES MADE BY THE BUREAU OF STANDARDS.

### I. OXIDE COMPOSITION

| | $SiO_2$ | PbO | BaO | ZnO | CaO | $Al_2O_3$ | $K_2O$ from $K_2CO_3$ |
|---|---|---|---|---|---|---|---|
| Light flint | 53.9 | 32.3 | ........ | ........ | 5.0 | ........ | 2.50 |
| Medium flint | 45.2 | 44.8 | ........ | ........ | 2.0 | ........ | 1.10 |
| Dense flint | 59.3 | 48.1 | ........ | ........ | 4.8 | ........ | 2.20 |
| Light crown | 53.7 | ........ | 10.6 | 1.5 | ........ | ........ | 3.7 |
| Barium crown | 48.0 | ........ | 26.5 | 8.4 | 2.0 | ........ | 4.0 |
| Dense barium crown | 39.0 | ........ | 45.0 | 7.0 | ........ | 1.00 | ........ |
| Borosilicate | 66.5 | ........ | 7.8 | 2.0 | ........ | ........ | 2.9 |
| Barium flint | 58.8 | 13.7 | 12.3 | 2.5 | 1.0 | ........ | 4.0 |

| | $K_2O$ from $KNO_3$ | $Na_2O$ from $Na_2CO_3$ | $Na_2O$ from borax | $As_2O_3$ | $Sb_2O_3$ | $B_2O_3$ from borax | $B_2O_3$ from boric acid |
|---|---|---|---|---|---|---|---|
| Light flint | 5.00 | 1.00 | ........ | 0.4 | ........ | ........ | ........ |
| Medium flint | 3.00 | 3.50 | ........ | .4 | ........ | ........ | ........ |
| Dense flint | 4.6 | ........ | ........ | .2 | 0.9 | ........ | ........ |
| Light crown | 1.3 | 10.87 | 1.43 | .4 | ........ | 3.50 | ........ |
| Barium crown | 4.0 | .15 | 1.86 | .5 | ........ | 4.26 | 0.33 |
| Dense barium crown | 2.6 | ........ | ........ | .4 | ........ | ........ | 5.00 |
| Borosilicate | 2.9 | 7.10 | 2.70 | .2 | ........ | 5.90 | 2.00 |
| Barium flint | 4.3 | 7.00 | 1.00 | ........ | ........ | 1.70 | ........ |

### II. BATCH COMPOSITION

| | $SiO_2$ | PbO | $BaCO_3$ | KnO | $Ca(OH)_2$ | $Al_2O_3$ | $KNO_3$ |
|---|---|---|---|---|---|---|---|
| Light flint | 49.1 | 29.0 | ........ | ........ | 6.26 | ........ | 9.50 |
| Medium flint | 42.2 | 41.4 | ........ | ........ | 2.55 | ........ | 5.90 |
| Dense flint | 36.9 | 45.2 | ........ | ........ | 4.51 | ........ | 9.45 |
| Light crown | 56.2 | ........ | 11.55 | 1.24 | ........ | ........ | 2.28 |
| Barium crown | 40.6 | ........ | 29.05 | 7.05 | 2.33 | ........ | 7.05 |
| Dense barium crown | 32.7 | ........ | 48.23 | 5.91 | ........ | 0.83 | 4.65 |
| Borosilicate | 56.9 | ........ | 8.88 | 1.67 | ........ | ........ | 5.81 |
| Barium flint | 51.3 | 11.9 | 15.94 | 2.11 | 1.22 | ........ | 7.94 |

| | $Na_2CO_3$ | $As_2O_4$ | $Sb_2O_3$ | Boric acid | Borax | $K_2CO_3$ |
|---|---|---|---|---|---|---|
| Light flint | 1.41 | 0.33 | ........ | ........ | ........ | 4.4 |
| Medium flint | 5.50 | .45 | ........ | ........ | ........ | 2.0 |
| Dense flint | ........ | .20 | 0.90 | ........ | ........ | 3.84 |
| Light crown | 15.45 | .33 | ........ | ........ | 7.23 | 5.72 |
| Barium crown | ........ | .40 | ........ | 0.47 | 7.10 | 5.86 |
| Dense barium crown | ........ | .33 | ........ | 7.35 | ........ | ........ |
| Borosilicate | 10.60 | .18 | ........ | 3.30 | 9.04 | 5.93 |
| Barium flint | 1.22 | .33 | ........ | ........ | 3.66 | 6.38 |

**Colored Glasses.**

A series of red glasses covering a wide range of composition have been made with the use of selenium and cadmium compounds and the heat treatment necessary for bringing out the color determined. Similar work has been done also with other colors, it being the intention to develop a complete series accompanied by spectroscopic and other optical determinations.

**Washington Glass Plant.**

The new melting furnaces, pot arches, annealing and molding ovens have been erected, and the plant is ready for operation.

Work has been begun on the making of disks for large lenses.

# III. THE OFFICE.

[Office management; finance and accounts; personnel actions and records; editorial work, printing, publicity; property and stores, including distribution and accounting; mail and files, including test records; scientific library; dispatch, including all forms of transportation and communication; purchasing; stenography, typewriting, and duplicating; and information service.]

## 1. GENERAL.

### ORGANIZATION.

During the fiscal year 1918–19 the office division has changed from a war to a peace basis. The Office is organized in 10 sections, and includes also all clerks assigned locally for the office work of the divisions. The sections are designated finance, personnel, publicity, property and stores, mail and files, library, dispatch, purchases, copying (detailed), information. Each section has a definite function, and it is the aim that each section shall handle all Bureau business which properly pertains to such function. This policy is equally true of the scientific sections and the sections of the mechanical plant.

During the year the organization has been making steady progress. A systematic plan of charting functions and procedure has resulted in greatly facilitating the handling of the Bureau's business. A simple and novel system of office organization is being perfected, the main features of which are as follows:

**Function chart, tabulating all Office functions, grouped into sections of related work.**

Process chart for each Office function (about 200 in all), showing actions and action points, diagrammatically tracing the course of action.

Standard practice, describing each step in each function clearly and completely enough to instruct a new clerk or an alternate.

Time standards showing for each function approximately the number of clerk hours required daily.

Office calendar, a schedule of all periodic functions.

Staff assignments, a chart of 12 diagrams showing assignment of staff to office functions.

Arrearage record, showing clerk hours arrearage for each function.

Arrearage adjustment, reassignment of staff to duties and duties to staff upon basis of (*a*) peak and valley loads of incoming work, (*b*) net resulting arrearage after temporary simplification or deferment during peak periods.

Residual arrearage is to be met by (*a*) permanent reduction of routine or more automatic methods, (*b*) transfer of work, or (*c*) estimates for extra help.

Alternate system by which absentee's work is handled by understudies, and during interim needed duties are handled, readjusted, or simplified.

**Space.**

The growth of the Bureau and the steadily increasing volume of work being handled call for additional space. In fact, the Director's offices, including the central administration, conference rooms, library reference room, and stacks, and the various sections of the Office division will eventually require an administrative building, preferably of the modern office type. It is hoped that plans will be prepared with a view to submitting such an estimate within a year or two. The present offices were designed to be available as laboratories and could be so used. It would be both economical and efficient to have the administrative building equipped with the special facilities required in the varied work of the central offices.

### Staff.

The readjustment of administrative salaries generally and of the wages of skilled workers emphasized the importance of providing a suitable scale of pay for the section chiefs in the Office sections and in the general scale of clerical salaries. A recommendation will be made to this effect in submitting the estimates. The equity of equal pay for equal training and experience is becoming recognized and being applied generally, assuming an acceptable standard of quality of work. The clerical work is essential work as important as any other, and the salaries should be commensurate, both to develop ability from the present personnel and to secure new appointees of ability when required. Given mental alertness, interest, and good physique, the necessary training can be acquired in the Bureau for practically all grades of work. Success has been shown in cases which appeared unpromising. Conscientiousness, interest, and esprit de corps are the strongest factors in securing efficient service, and it is believed that the success of the Office work during the past year has been largely due to these qualities in the Office staff.

## 2. SECTIONS.

### FINANCE.

(Records of appropriations and allotments; order and voucher accounts; balances; reimbursements; checking commercial, construction, and travel expense vouchers; pay rolls; test fees; fiscal statistics.)

### Funds and Disbursements.

The regular appropriations of the Bureau, including the war funds, amounted to $1,266,860. In addition, $479,300 was assigned by the President to the Bureau from the national security and defense fund for special investigations on war problems and to complete laboratories under construction. At the request of several departments of the Government the Bureau undertook special cooperative researches, for which purpose approximately $643,000 was allotted to the Bureau. The Bureau appropriations were also directly reimbursed by about $285,000. The total expenditures during the year amounted to approximately $2,674,160.

### Staff.

After the signing of the armistice the accounting staff was reduced by three, although the numerous reimbursements entailed much extra work in rendering the necessary vouchers and following the cases through to final settlement. The assignment of a clerk as "voucher runner" has greatly facilitated the payment of vouchers. Close watch is kept on the location of vouchers within the Bureau to reduce delay at all points along the line. The transfer of the audit staff to the north building temporarily relieved the congestion in the quarters of the finance section.

**Office System.**

The installation of a special card system and visible index for pay rolls resulted in a quicker and more accurate method of preparing the rolls. The numerous Bureau funds, and allotments within the Bureau (about 250 in all), made it essential to have some quick method of reference. A visible index is now being used for this purpose, and this clearly indicates at a glance the titles and amounts of appropriations, allotments, funds from other sources, etc.

**Appropriation Statements.**

The following statement shows the amount and object of each appropriation provided for the Bureau for the fiscal year 1919, the disbursement during the year, the amount of unfilled and unpaid orders at the close of the year, and the unexpended balance remaining at the close of business June 30, 1919:

| Appropriation. | Amount appropriated. | Disbursements. | Liability. | Balance. |
|---|---|---|---|---|
| Salaries | $432,360.00 | $342,545.03 | $33,690.28 | $56,124.69 |
| Equipment | 75,000.00 | 54,322.44 | 18,020.05 | 2,657.51 |
| Repairs and alterations | 6,000.00 | 5,688.11 | 305.58 | 6.31 |
| General expenses | 50,000.00 | 18,969.55 | 28,199.64 | 2,830.81 |
| Grounds | 7,500.00 | 4,672.18 | 2,736.40 | 91.42 |
| High-potential investigation | 15,000.00 | 11,429.08 | 3,502.26 | 68.66 |
| Testing structural materials | [a] 222,733.04 | 212,166.50 | 7,636.81 | 2,929.73 |
| Testing machines | 30,000.00 | 26,314.13 | 3,304.88 | 380.99 |
| Investigation fire-resisting properties | 25,000.00 | 21,057.38 | 3,485.48 | 457.14 |
| Investigation public-utility standards | [b] 55,394.84 | 44,594.04 | 5,519.56 | 5,281.24 |
| Investigation railway materials | 15,000.00 | 12,053.25 | 2,800.15 | 146.60 |
| Testing miscellaneous materials | 30,000.00 | 24,706.35 | 4,602.15 | 691.50 |
| Radio research | 20,000.00 | 18,763.23 | 1,231.00 | 5.77 |
| Color standardization | 10,000.00 | 8,143.04 | 1,800.56 | 56.40 |
| Investigation clay products | 20,000.00 | 16,329.91 | 3,391.13 | 278.96 |
| Determining physical constants | 5,000.00 | 4,540.40 | 433.38 | 26.22 |
| Standardizing mechanical appliances | 10,000.00 | 5,315.43 | 4,620.80 | 63.77 |
| Investigation of optical glass | [c] 84,388.75 | 70,213.74 | 12,653.68 | 1,521.33 |
| Standard materials | 4,000.00 | 3,278.02 | 641.97 | 80.01 |
| Investigation of textiles, etc | 10,000.00 | 6,407.06 | 3,129.28 | 463.66 |
| Sugar technology standards | [d] 21,350.00 | 15,731.47 | 5,512.69 | 105.84 |
| Gauge standardization | [e] 433,000.00 | 367,291.84 | 64,329.28 | 1,378.88 |
| Renewal of storage batteries | 20,000.00 | 2,575.09 | 16,358.25 | 1,066.66 |
| Military research, 1918–19 | [f] 566,547.68 | 510,211.49 | 45,574.00 | 10,762.19 |
| Investigation of mine scales and cars 1918–19 | 15,000.00 | 10,796.17 | 4,005.08 | 198.75 |
| Investigation of public-utility companies, 1918–19 | [g] 53,522.52 | 38,813.98 | 14,024.11 | 684.43 |
| Testing railroad scales etc | 40,000.00 | 35,220.83 | 4,102.73 | 676.44 |
| NATIONAL SECURITY AND DEFENSE. | | | | |
| Military researches | 100,000.00 | 59,941.04 | 36,712.06 | 3,346.90 |
| Robert's coke oven | 80,000.00 | 29,753.46 | 45,312.99 | 4,933.55 |
| Thermite investigation | 4,300.00 | 3,454.25 | 780.16 | 65.59 |
| Altitude laboratory | 60,000.00 | 59,897.19 | ............ | 102.81 |
| Power plant equipment (industrial laboratory) | 31,500.00 | 34.86 | 31,459.75 | 5.39 |
| Completing laboratories | 235,000.00 | 169,327.32 | 65,024.68 | 648.00 |
| Armament of fortifications, Commerce transfer | [h] 131,850.00 | 58,872.71 | 72,875.93 | 101.36 |
| Aviation, Navy, Commerce transfer | 5,000.00 | 4,177.14 | 821.86 | 1.00 |
| Equipping laboratory, 1919–20 | 100,000.00 | 3,026.92 | 17,882.22 | 79,090.86 |
| Industrial research, 1919–20 | 50,000.00 | 5,195.11 | 383.13 | 44,421.76 |
| Total | 3,074,446.83 | 2,285,829.74 | 566,863.96 | 221,753.13 |

[a] Includes reimbursement of $129,000 from other departments.
[b] Includes reimbursement of $5,394.84 from other departments.
[c] Includes reimbursement of $64,388.75 from other departments.
[d] Includes reimbursement of $1,350 from other departments.
[e] Includes allotment of $283,000 from War Department.
[f] Includes reimbursement of $216,547.68 from other departments.
[g] Includes reimbursement of $3,522.52 from other departments.
[h] Includes reimbursement of $31,850 from other departments.

The following statement shows the condition of the appropriation for the two preceding fiscal years at the close of business June 30, 1919:

| Appropriation. | Amount appropriated. | Disbursements. | Liability. | Balance. |
|---|---|---|---|---|
| FISCAL YEAR 1917. | | | | |
| Salaries | $311,720.00 | $289,777.80 | ............ | $21,942.20 |
| Equipment | 50,000.00 | 49,613.52 | $386.48 | ............ |
| General expenses | 28,500.00 | 28,276.36 | 223.64 | ............ |
| Repairs and alterations | 5,000.00 | 4,731.39 | 34.85 | 233.76 |
| Grounds | 6,000.00 | 5,935.67 | ............ | 64.33 |
| High-potential investigation | 15,000.00 | 14,874.83 | 4.40 | 120.77 |
| Refrigeration constants | 15,000.00 | 14,934.19 | 15.00 | 50.81 |
| Testing structural materials | 100,000.00 | 99,014.41 | 259.08 | 726.51 |
| Testing machines | 30,000.00 | 29,716.27 | 29.69 | 254.04 |
| Investigating fire-resisting properties | 25,000.00 | 24,910.75 | ............ | 89.25 |
| Public-utility standards | 40,000.00 | 39,704.87 | 20.04 | 275.09 |
| Railway materials | 15,000.00 | 14,856.49 | 92.34 | 51.17 |
| Testing miscellaneous materials | 20,000.00 | 19,901.12 | 2.17 | 96.71 |
| Radio research | [a] 15,359.71 | 14,651.73 | ............ | 707.98 |
| Color standardization | 10,000.00 | 9,740.45 | 100.00 | 159.55 |
| Clay products | 10,000.00 | 9,973.39 | ............ | 26.61 |
| Physical constants | 5,000.00 | 4,471.62 | 57.53 | 470.85 |
| Standardizing mechanical appliances | 10,000.00 | 9,482.84 | 343.87 | 173.29 |
| Testing railroad scales, etc | 44,750.00 | 44,558.89 | 52.58 | 138.53 |
| Equipping chemical laboratory, 1916-17 | 35,000.00 | 34,790.70 | 209.30 | ............ |
| Equipping chemical laboratory, 1917-18 | 35,000.00 | 34,697.59 | 5.26 | 297.15 |
| Radio laboratory | 90,000.00 | 86,688.97 | 3,277.00 | 34.03 |
| Total | 916,329.71 | 885,303.85 | 5,113.23 | 25,912.63 |
| FISCAL YEAR 1918. | | | | |
| Salaries | 348,900.00 | 316,613.53 | ............ | 32,286.47 |
| Equipment | 55,000.00 | 53,670.45 | 1,329.55 | ............ |
| General expenses | 35,000.00 | 33,563.57 | 599.43 | 837.00 |
| Repairs and alterations | 5,000.00 | 4,945.18 | 46.00 | 8.82 |
| Grounds | 6,000.00 | 5,801.66 | 47.66 | 150.68 |
| High-potential investigation | 15,000.00 | 14,182.62 | 658.47 | 158.91 |
| Testing structural materials | [b] 204,773.83 | 177,199.80 | 27,319.21 | 254.82 |
| Testing machines | 30,000.00 | 29,140.89 | 440.88 | 418.23 |
| Investigation of fire-resisting properties | 25,000.00 | 24,849.62 | 33.19 | 117.19 |
| Public-utility standards | 50,000.00 | 49,928.19 | 71.81 | ............ |
| Investigation of railway materials | 15,000.00 | 14,498.73 | 212.27 | 289.00 |
| Testing miscellaneous materials | 20,000.00 | 19,951.28 | 28.84 | 19.88 |
| Radio research | 10,000.00 | 9,969.24 | ............ | 30.76 |
| Color standardization | 10,000.00 | 9,381.30 | 532.88 | 85.82 |
| Investigation of clay products | 10,000.00 | 9,994.53 | ............ | 5.47 |
| Physical constants | 5,000.00 | 4,994.31 | ............ | 5.69 |
| Standardizing mechanical appliances | 10,000.00 | 9,563.18 | 9.65 | 427.17 |
| Investigation of optical glass | 10,000.00 | 9,789.78 | 135.50 | 74.72 |
| Testing railroad scales | 40,000.00 | 39,591.44 | 165.57 | 242.99 |
| Additional land | 25,000.00 | ............ | ............ | 25,000.00 |
| Military research, 1917-18 | [c] 485,818.01 | 444,415.32 | 35,800.69 | 5,602.00 |
| Gauge standardization, 1917-18 | [d] 226,972.47 | 222,746.62 | 3,539.40 | 686.45 |
| Repairs, power plant | 12,000.00 | 11,566.87 | 177.70 | 255.43 |
| *National security and defense.* | | | | |
| Production of optical glass | [e] 112,762.00 | 108,222.22 | 1,473.92 | 3,065.86 |
| New building | 250,000.00 | 249,070.44 | 877.09 | 52.47 |
| Metallurgical work | 100,000.00 | 97,606.07 | 2,146.63 | 247.30 |
| Production of fabrics | 35,000.00 | 24,904.23 | 10,678.28 | 17.49 |
| Industrial laboratory | 893,500.00 | 883,223.97 | 9,796.03 | 480.00 |
| Robert's coke oven | 5,000.00 | 4,633.45 | 76.61 | 289.94 |
| Thermite investigation | 700.00 | 651.60 | 4.00 | 44.40 |
| Total | 3,051,426.31 | 2,884,670.09 | 95,601.26 | 71,154.96 |

[a] Includes reimbursement for $15,359.71.
[b] Includes reimbursement of $54,773.83 from other departments.
[c] Includes reimbursement of $235,818.01 from other departments.
[d] Includes reimbursement of $1,972.47 from other departments.
[e] Includes reimbursement of $37,762 from other departments.

## Summary of Tests.

The Bureau's work includes, among other things, a large amount of testing standards, measuring instruments, and materials. Incident thereto much testing involves primarily the investigation of the scientific principles underlying the tests, the studying of existing methods, and the development of new standard tests of determinate accuracy. For each test a reasonable fee is charged, except when made for the National or State Governments.

During the fiscal year 1918–19 the Bureau made 124,668 tests and inspected 5,076,961 incandescent lamps at various factories for other departments of the Government. Of the total tests, 110,468 were for the Government and 14,200 for the public. The testing was distributed as follows, according to the nature of the tests: Length measures, 9,951; mass, 2,022; capacity, 186; optical, 2,161; hydrometry, 3,485; time, 2,278; temperature, 19,164; electrical, 3,570; photometry, 3,510; chemical, 22,664 (physical and mechanical tests); engineering material, 1,593; structural material, 44,738; paper and textile, 8,162; metallurgical, 539; aeronautical instruments, 645. The estimated fees amount to $677,873.64, of which $21,169.16 was collected on account of tests for the public. The fees noted for Government tests were included merely for comparison purposes, as no fees are charged for tests performed for the National or State Governments.

### NUMBER AND VALUE OF TESTS COMPLETED, FISCAL YEAR ENDING JUNE 30, 1919.

### AT WASHINGTON.

| Nature of test. | For Government. | | For public. | | Total. | |
|---|---|---|---|---|---|---|
| | Number. | Value. | Number. | Value. | Number. | Value. |
| Length | 9,482 | $14,477.45 | 469 | $598.10 | 9,951 | $15,075.55 |
| Mass | 1,060 | 26,785.10 | 962 | 491.30 | 2,022 | 27,276.40 |
| Capacity | 136 | 1,203.21 | 50 | 112.25 | 186 | 1,315.46 |
| Optical | 1,863 | 4,171.50 | 298 | 1,372.46 | 2,161 | 5,543.96 |
| Hydrometry | 1,360 | 1,047.35 | 2,125 | 1,080.75 | 3,485 | 2,128.10 |
| Time | 2,194 | 867.25 | 84 | 309.50 | 2,278 | 1,176.75 |
| Temperature | 15,892 | 3,379.81 | 3,272 | 3,568.95 | 19,164 | 6,948.76 |
| Electrical | 1,878 | 7,738.25 | 1,692 | 5,499.75 | 3,570 | 13,238.00 |
| Photometry [a] | 3,421 | 12,989.00 | 89 | 307.75 | 3,510 | 13,296.75 |
| Chemical [b] | 19,264 | 198,461.01 | 3,400 | 6,549.35 | 22,664 | 205,010.36 |
| Physical and mechanical— | | | | | | |
| Engineering material | 1,538 | 6,492.00 | 55 | 234.00 | 1,593 | 6,726.00 |
| Structural material | 43,166 | 338,496.05 | 1,572 | 507.00 | 44,738 | 339,003.05 |
| Pittsburgh laboratory | 3,572 | 11,606.50 | 48 | 165.00 | 3,620 | 11,771.50 |
| Paper and textile | 8,096 | 30,253.00 | 66 | 262.25 | 8,162 | 30,515.25 |
| Metallurgical | 522 | 1,616.00 | 17 | 196.00 | 539 | 1,812.00 |
| Aeronautical instruments | 596 | 8,727.50 | 49 | 79.75 | 645 | 8,807.25 |
| Total | 114,040 | 668,310.98 | 14,248 | 21,334.16 | 128,288 | 689,645.14 |

### AT PITTSBURGH.

| | | | | | | |
|---|---|---|---|---|---|---|
| Cement | 2,804 | $7,924.00 | | | 2,804 | $7,924.00 |
| Clay products | 61 | 673.00 | | | 61 | 673.00 |
| Miscellaneous | 122 | 936.00 | 47 | $155.00 | 169 | 1,091.00 |
| Chemical | 585 | 2,073.50 | 1 | 10.00 | 586 | 2,083.50 |

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[a] In addition the Bureau inspected 5,076,961 incandescent lamps at various factories for other departments of the Government, the fees for which would amount to $12,692.40.

[b] Of these tests 8,091, amounting to $121,365. were chemical tests made on structural material.

## PERSONNEL.

**(Organization charts of divisions; staff status, individual records of all employees, including military employees; appointments and personnel changes; directories; systems of examinations; records of leave, tardiness, delinquency, and efficiency; passes and credential cards; injury and first-aid records and reports; and records of employees who have entered the military service.)**

The work in the personnel section covers a wide range of functions, all pertinent to personnel work, but involving a large volume of clerical detail. All of such routine has been carefully standardized, and a system of process charts was adopted. Each function shows the steps required and the action points. These serve as a guide in standardizing procedure and to instruct new clerks.

### Present Personnel.

During the year the Bureau staff comprised 341 statutory employees and about 809 engaged in research and investigations specially authorized by Congress. The statutory positions included 201 scientific positions, 52 office assistants, 55 engaged in the operation of the plant, and 33 in the construction. In addition to the above there were 300 employees detailed from other Government departments and organizations during the year for work in the Bureau. The Bureau more than doubled its force during the war.

### Effect of War and Armistice on Personnel.

The personnel at present consists of over 1,000 regular appointed employees, as compared with approximately 500 prior to the war. The highest number of employees at any one time during the year was approximately 1,450, of which 300 included detailed employees from the Army, Navy, or other Government establishments. On June 30, 1919, there were 1,140 employees, of which 60 were detailed employees. The above figures show that the force has been reduced by approximately 310 employees since the armistice was signed. These included 240 detailed employees and 70 regular employees.

### Personnel Changes.

There were 4,300 personnel changes during the year. These included 1,505 separations from the Bureau, of which 378 were resignations, 774 promotions, and 1,909 appointments. The high labor turnover will give some idea as to the large amount of work required in keeping positions filled. How serious is the unusually heavy drain, due to the demand for trained employees, is shown by the fact that 1,505 out of a total force of 1,909 regular appointed employees, or over 78 per cent, left the service during the past year. A detailed statement of the personnel changes is given in the following table:

PERSONAL CHANGES, 1918–19.

| Nature of position. | Appointments. | Separations. |
|---|---|---|
| Competitive | 554 | 372 |
| Excepted | 14 | 1 |
| Unclassified | 27 | 5 |
| Total permanent | 595 | 378 |
| Temporary | 1,314 | 1,127 |

*Summary.*

| | |
|---|---|
| Appointments | 1,909 |
| Separations | 1,505 |
| Promotions | 774 |
| Reductions | 23 |
| Other changes | 89 |
| Total personnel changes | 4,300 |

### Personnel Records.

The personnel charts were revised during the year and placed in book form, with a new type of visible index. This provides a neat graphic record of the staff status instantly accessible and visible and facilitates the entries of personnel changes. A list of all employees by grades and seniority on all funds was compiled during the year. This record is on a visible index file and shows at a glance all employees in each grade by seniority. Such data are so often called for that considerable time will be saved in preparing lists. An efficiency record is kept of all junior employees.

### Annual and Sick Leave.

The following table shows the total and average amount of annual and sick leave taken by the employees of the Bureau during the calendar year 1918:

| Leave. | Days. | Average. |
|---|---|---|
| Annual | 6,362 | 15.0 |
| Sick | 2,296 | 5.4 |
| Total, 1918 | 8,658 | 20.4 |
| Average in 1917 | | 24.8 |

### Eligibles.

A satisfactory arrangement was effected to secure prompt certification of eligibles in important cases. This saves at least 10 days in making appointments. Owing to the variety of experts required and the heavy demand for labor, the civil-service registers proved inadequate. It was necessary to seek temporary assistants in nearly 75 per cent of the cases, nearly all of whom subsequently qualified by examination and were given permanent appointments.

### Employees in Military Service.

Approximately 90 employees left the Bureau to enter the organized military service during the war, 2 of these having been killed in action, 1 dying of disease, and 1 dying by accident. Employees who entered the military service and who have applied for reinstatement are being restored to the Bureau rolls in their old positions. In no case has the salary offered been less than that which the employee was receiving when he left the service. Many of the Bureau's experts were necessarily retained for scientific research in connection with military problems.

### Additional Work.

The method prescribed by law for recommending employees for the bonus entails much extra work on the personnel section. Individual recommendation is required in each case where the employee has entered the service since June 30, 1918, or where employees have been promoted in excess of $200 since that date. It is also necessary to keep records of the bonus for immediate reference, it being necessary to verify each change in an employee's status. Detailed data is also furnished to the Commission on Reclassification of Salaries as to each personnel change, and duties of old and new positions.

## PUBLICATIONS.

(Editorial work, routing of manuscripts and proof documents; archives; handling requests for publications, preparing franks; publication stock distribution; abstracts of publications.)

### Publications Issued During Year.

The publication work of the Bureau was reduced to a minimum during the war, so that all possible service might be rendered to the military departments directly in experimental and investigational work. However, during the fiscal year the Bureau issued 53 publications, 36 of which were new and 15 revised editions. Forty publications were reprinted without revision. The new publications comprised 12 scientific papers, 15 technologic papers, 6 circulars, and 3 miscellaneous publications, as listed below:

### Scientific Papers.

Wave Lengths in the Red and Infra-red Spectra of Iron, Cobalt, and Nickel Arcs.

Spectroradiometric Investigation of the Transmission of Various Substances.

Electrical Oscillations in Antennas and Inductance Coils.

Measurements on the Index of Refraction of Air for Wave Lengths from 2218-A to 9000-A.

Variance of Measuring Instruments and Its Relation to Accuracy and Sensitivity.

Measurements of Wave Lengths in the Spectrum of Neon.

The Decrease in Ultra-Violet and Total Radiation with Usage of Quartz-Mercury Vapor Lamps.

A Relation Connecting the Derivatives of Physical Quantities.

Preliminary Determination of the Thermal Expansion of Molybdenum.

Optical Conditions Accompanying the Striæ Which Appear as Imperfections in Optical Glass.

A Simplification of the Inverse-Rate Method for Thermal Analysis.

Combustible-Gas Detectors.

### Technologic Papers.

Determination of Permeability of Balloon Fabrics.

A Portable Cubic-Foot Standard for Gas.

New Baumé Scale for Sugar Solutions.

Silica Refractories—Factors Affecting their Quality and Methods of Testing the Raw Materials and Finished Ware.

Toluol Recovery.

A Critical Study of the Ledebur Method for Determining Oxygen in Iron and Steel.

The Ultra-violet and Visible Transmission of Eye-protective Glasses.

Tests of Hollow Building Tiles.

Strength and Other Properties of Wire Rope.

Tests of Eighteen Concrete Columns Reinforced with Cast Iron.

Physical and Chemical Tests of the Commercial Marbles of the United States.

Constitution of Silica Brick and Changes Involved Through Repeated Burnings at High Temperatures.

Viscosity of Gasoline.

A Study of the Goutal Method for Determining Carbon Monoxide and Dioxide in Steel.

The Effect of Solar Radiation upon Balloons.

### Circulars.

Publications of the Bureau of Standards.
Aluminum and Its Light Alloys.
The Table of Unit Displacement of Commodities.
Solders for Aluminum.
Electrical Characteristics and Testing of Dry Cells.
Recommended Specification for Linseed Oil—Raw, Refined, and Boiled.

### Miscellaneous.

Proceedings of the Second Annual Textile Conference Held at the Bureau of Standards (1917).
Metric Manual for Soldiers.
Annual Report of the Director for Fiscal Year Ended June 30, 1918.

### Distribution.

As provided by law documents are mainly distributed by the Superintendent of Documents. A proper selection of suitable publications to be sent in response to many of the requests for technical data can be made only in close contact with the technical sections of the Bureau. The franks, therefore, are prepared at the Bureau in the publication section.

### List of Publications.

During the year the Bureau completed and published a full list of publications issued by the Bureau since its establishment. The catalogue is descriptive and gives for each title a technical abstract of the publication, and a comprehensive index. The Bureau will issue a quarterly supplement to include new publications published during the quarter. This list of publications has already proved of great value in guiding the economical and efficient distribution of Bureau publications. The abstract gives so clearly the nature of the subject matter that an expert can promptly decide whether the publication meets his need. The abstracts form an excellent summary of the entire published work.

## PROPERTY AND STORES.

(Property inspection; quantity and quality checking; accession, recording; accountability, charge and release; condemnation and disposal; stores, stock distribution, and renewals.)

### Equipment.

During the year 50,000 pieces of equipment were received, serially numbered, and taken up on the inventory records. New engraving and stenciling machines were procured to facilitate the placing of Bureau accession numbers on all pieces of equipment.

### Perpetual Inventory Records.

The improved system of perpetual inventory records is now fully established. All necessary record entries are made at one writing in place of the three separate writings formerly required. This greatly facilitates prompt local and central handling of inventory and property transfers.

### Technical Supplies.

During the year technical supplies valued at $65,000 were issued to the various technical divisions and offices. The systematic arrangement and segregation of technical supplies in the storeroom enable the attendants to give quick service, each class of stock having a specific and indexed location. The new card system shows at a glance all stock on hand, amounts issued, and organization unit drawing the same. This permits the complete accounting for all supplies issued and charging of same to proper units. The system works well, and the main storeroom is now supported wholly by reimbursement from allotments to the various divisions.

### Additional Space Needed.

Additional space is seriously needed to permit the stock to be kept on one floor, systematically arranged on shelves according to classes of material. The main stock supply is now in the attic. Suitable quarters would reduce by two-thirds the labor in handling supplies, and the attendants could more promptly and efficiently serve the technical needs.

## MAIL.

(Handling of incoming and outgoing correspondence of all kinds; the accession, distribution, and filing of such papers.)

### Filing System.

Marked progress was made during the year in perfecting the central filing system. An accurate check is now available for the location of each letter. Two sets of reference slips are filed, one according to organization unit of reference and one according to date, the file for incoming and outgoing letters being kept separate. This has saved appreciably in time and labor, and promoted the efficient handling of correspondence.

### New Equipment.

A new motor-driven letter opener saves the time of one employee previously needed for the work. A new device designed and constructed at the Bureau is used to photograph all important incoming mail, using for the purpose a motion-picture film. The photographic reference record of incoming letters, by means of a suitable projector, is used to throw the image of the letter on the screen. The original letters, as soon as photographed, are at once available for distribution to the divisions of the Bureau. The saving of one to two hours' delay enables the mail section to deliver the morning mail to the laboratories by 10 o' clock.

### Subject Filing.

The Bureau correspondence is filed by subject. In each unit subject, however, a series of monthly folders facilitates the transfer of back correspondence. This simple device greatly simplifies the clearing of the current files and transfer to the permanent cases.

### Filing Equipment.

The new equipment obtained for properly handling the large volume of correspondence has included a sorting cabinet, small-letter sorters, filing units, transfer cases, and visible guides. Floor space urgently needed for systematic storage of back correspondence and records is now available, since the photographic shop is transferred to the industrial laboratory.

### Personnel.

The mailroom staff has shown cooperation to a marked degree in excelling previous performance in the proper handling of the

Bureau's correspondence. The arrearage of work occasioned by the loss of experienced clerks due to the war has been gradually overcome, and with new equipment already ordered the work can speedily be brought up to date.

### LIBRARY.

**(Maintenance of scientific and technical library; bibliography; selection of new reference books; preparing book lists for purchases; accessioning new books; loans and accountability records; assistance to technical staff; and binding of books and periodicals.)**

#### Accessioned Volumes.

At the close of the fiscal year the technical library of the Bureau had 17,742 accessioned volumes. Except for a few law books, these are all of scientific and technical character, chiefly in the subjects of physics, chemistry, engineering, and special technology. During the fiscal year 346 new volumes were accessioned.

#### Technical Journals.

The Bureau receives currently 442 scientific and technical periodicals. During the year steps were taken toward completing some of the more important sets which are in great demand at the Bureau. About one-half of the periodicals are received by exchange with the Bureau's publications. The following is an interesting analysis of the technical journals currently received, including a statement of the total number of separate parts:

| | Subscription. | Exchange. | Total journals. | Total parts. |
|---|---|---|---|---|
| American | 84 | 115 | 199 | 3,889 |
| British and others in English | 49 | 55 | 104 | 1,645 |
| French and others in French | 17 | 21 | 38 | 584 |
| German | 69 | .......... | 69 | 1,640 |
| Others | 3 | 29 | 32 | 284 |
| Total | 222 | 220 | 442 | 8,042 |

#### Circulation.

Apart from the consultation of books in the library itself and the desk copies of important texts permanently assigned to the laboratories, there was a monthly average circulation of 500 books and journals. Through the cooperative arrangement with the various libraries in Washington, more than 500 loans were made to the Bureau. In return, the Bureau makes loans to experts in other institutions and tenders the Bureau's facilities and library for consultation and reference.

#### Additional Space.

In common with every other section of the office, additional space is urgently needed. A new periodical rack is required and additional stacks. The Bureau's library is increasing at a rate to demand approximately 50 additional shelves per year. Furthermore, the question of consolidating the overflow library now located in the attic and transferring it to the main library should receive early attention. This can be done when additional space and stacks are available.

## DISPATCH.

(Transportation and communication of all kinds, comprising telephone and telegraph service, express, freight, and mail shipments, drayage, motor-cycle, and other messenger service in and out of the Bureau.)

### Shipping.

The consignments handled by the dispatch section of the Bureau during the past year far exceeded the business of any previous year. The system for recording the same has been in successful and satisfactory operation during the year. In view of the variety and the delicate or dangerous nature of the many instruments and materials shipped, the results are gratifying. However, with the consolidation of the Pittsburgh laboratory and the desirability of improving the promptness of the service, especially during peak periods, at least one experienced packer and two laborers should be added to the shipping-room staff.

### Quarters.

The present temporary quarters suffice for the present. Permanent provision should be made—probably in another building—for a well-designed shipping room, with loading platform and modern facilities for good traffic management.

## PURCHASE.

(Trade catalogues and dealers' lists; requisition inspection; preparation of bids, requests, advertising, and orders; order follow up; purchase and transportation checking.)

### Requisitions and Orders.

During the year 8,800 requisitions were placed for supplies and equipment necessitating special orders. A shortening of the routine now permits all orders to be mailed the same day as written, saving a full day's time in each case. The purchase section has placed travel-authorization requests on the same basis as orders, and is handling them efficiently.

### Records.

An excellent system of records is in successful operation, and needed information is obtainable promptly. The follow up established during the year proved effective in expediting the checking of material received and payment of vouchers. A special clerk designated as "voucher runner" sees to it that all accounts are handled promptly, or adequate reason is given.

### Bids.

The last appropriation act requiring that bids be solicited of all Government departments before purchasing from outside contractors greatly increased the work of securing material and involves some delay in securing needed equipment and supplies.

### Space and Assistance.

The concentration of purchase work in the purchase section has entailed much extra work for which additional assistance should be provided to carry it efficiently. Larger quarters will be needed or the efficiency of this service will be impaired.

### Catalogue Library.

The Purchase Section maintains an excellent catalogue library arranged alphabetically, by firms, and indexed by classes of articles, including especially scientific and technical equipment and supplies. In addition a record is kept of the location of all catalogues assigned or loaned to the staff.

## COPYING.

(Editing rough drafts of letters, reports, and manuscripts; stenography; typewriting; and mimeography.)

The purpose of the copying section can not be efficiently served until an adequate force of typists is available to take over all the principal dictation and general typewriting of the office section. If this proves feasible, the consolidation should be extended to include most of the work of the scientific and technical sections.

The members of the copying section assisted in preparing the details of office practice and procedure charts, including organization charts of routine, staff assignment, and functions in connection with the general office-organization plan. The plan is novel and comprehensive. The details are described in another part of this report. Other work of the section included the loaning of temporary assistance in case of illness or absence on leave, the handling of peak loads of work in various parts of the Bureau, mimeograph work, and the taking of miscellaneous dictation.

The plan for the development of a copying section includes the ultimate provision for a sufficiently large room where all clerks engaged in copying work could work systematically together, so that the assignment and systematic record of work could be facilitated.

## INFORMATION.

(Reference of technical correspondence; maintenance of a progress-of-work chart and follow-up system covering all tests, subjects of inquiry, investigations, and researches in progress for the military services and to some extent for civilian agencies; requesting, receiving, distributing, and filing of scientific and technical information of a military bearing.)

### Progress-of-Work Records.

The initiation and progress of tests, investigations, and researches is charted for military and related work. This now includes the more important nonmilitary work. This forms an available and full list of the more important technical activities of the Bureau. During the year 4,209 separate military entries were carried on the progress-of-work chart, averaging 351 per month, and, in addition, 220 important industrial investigations were charted. The entries include dates of incoming letter, receipt at the Bureau, receipt of the materials or specimens to be tested, and of preparation of final report and its mailing, and also the subjects of incoming and outgoing correspondence concerning the case. A systematic follow up and record thereof is provided.

The novel form of chart and notation used has attracted interest outside and is being published by a firm publishing forms and digests of data for technical work.

### Distribution of Technical Information.

The Bureau receives many technical and scientific data, to some extent confidential in character. The sources include the Research Information Service of the National Research Council, the Air Service Information Group, the reference library of the Ordnance

Department of the Army, the Bureau of Construction and Repair of the Navy Department, and the National Advisory Committee for Aeronautics. Such data are referred to the proper technical division to be utilized as promptly and fully as possible.

The information section also obtains upon request of any authorized member of the staff documents of this character available at any of the usual sources of such information. Six hundred and twenty-one separate documents of this character have been secured on such requests during the past nine months.

### Technical News Bulletin.

The Bureau has dispatched at frequent intervals since December, 1917, to the military and naval technical and executive authorities and other cooperating services, a confidential bulletin of brief current news of technical and scientific progress in the Bureau's laboratories. The diffusion of up-to-date data made it possible for officers of other services concerned to arrange for needed cooperative work and for early application of the results when exigent work required.

Recently the confidential nature of the bulletin has been largely eliminated, and it is now issued as the Technical News Bulletin of the Bureau of Standards, a few confidential matters of military importance being reserved for a confidential supplement sent only to a restricted mailing list. During the past fiscal year the confidential or news bulletin has included 135 single-spaced mimeographed pages, under a total of 426 separate subject headings. The many inquiries for information about work in progress based upon this bulletin shows that it has performed useful service in making technical information available for early use.

### Miscellaneous Information Service.

The information section handles many inquiries by telephone and otherwise for information regarding the Bureau's work and puts the inquirer in touch with the proper staff expert, a matter of importance now that the organization is so large and comprises so many and varied activities. Compilations of information required for various purposes are also undertaken—as, for example, at the request of the War Department a history of the Bureau's technical participation in the work of aircraft production—and for general use and information an analysis of the memberships of experts of the Bureau staff in committees of the various technical and scientific societies with which the Bureau cooperates.

# IV. ENGINEERING AND CONSTRUCTION.

## 1. POWER PLANT, BUILDINGS AND GROUNDS, AND TRANSPORTATION.

[Power-plant operation, automobile and truck service, electrical and plumbing installation and standardization of testing apparatus and conditions; general photography.]

### Operation and Maintenance of Mechanical Plant.

The operation and maintenance of the power plant is a very important part of the work of the engineering division, in that the entire Bureau is dependent thereon for the various laboratory facilities. The power plant comprises the heating, generating, and refrigeration equipment, the compressed air, vacuum, and high-pressure water services, and the storage-battery equipment, both stationary and portable. During the past year a number of additions were made to the several types of equipment of the plant in those departments which were critically in need of additional facilities. Two 200-horsepower boilers were put in operation during the past winter and made possible adequate heating of the Bureau. At present the intallation of two 350-horsepower boilers in the basement of the kiln building for heating the industrial and kiln buildings is nearing completion. Additions to the electrical equipment during the year include a 300-kilowatt synchronous converter and 200 kilovolt-amperes in transformers. The converter, while not exactly satisfactory from an operating standpoint, is, nevertheless, a great help in insuring uninterrupted direct-current service. The transformers were added in order to accommodate several large electric furnaces installed for the metallurgical and heat and thermometry divisions.

The stationary storage batteries were renewed during the year and put in excellent condition, a special appropriation having been provided for the purpose. A number of new portable storage batteries were also added to the plant equipment. The rapid expansion of the Bureau in all its branches, due to its war-time activities, has placed a severe strain on the power plant, and, while the additions above mentioned have provided means for temporarily supplying the various laboratory facilities, the present arrangement of the power-plant equipment is far from satisfactory both from an operating standpoint and on account of the sizes of the units and variety of equipment, and must, therefore, be considered as only of a temporary nature. For instance, the entire floor space of the present engine room has been used for machinery and switchboards, and the synchronous converter necessarily placed in the northwest building, some distance away; the boilers in the kiln building will require separate operating crews, both of these cases being an indication of how the operation of the plant has become decentralized. It was with difficulty that the operation of the plant was managed during the past winter, and it was only made possible with several labor-saving devices which were put into effect in the method of coal and ash handling. The construction of a separate heating and generating plant, including all the mechanical equipment adequate for the present and future requirements of the Bureau, should be undertaken at once not only as essential to better efficiency, but also as a necessity against serious interruptions of service, which are, indeed, quite probable with the present plant. The plant has expanded to a point where further temporary expansion is almost impossible, and its capacity is frequently taxed almost to the limit.

### Transportation.

The operation and maintenance of the transportation equipment of the Bureau is cared for by this section of the engineering division. The equipment consists of 2 touring cars, 1 ambulance, 1 mail truck, and freight-handling trucks of the following capacities: One 2½-ton, two ¾-ton, two 500-pound. Owing to the very large increase in the work of the Bureau, due to its war activities, the importance of maintaining adequate truck service to handle the freight, express, etc., with dispatch is readily apparent. The maximum service possible was obtained from the various machines, and consequently hard usage has rendered some of the trucks unfit for much more useful service. Steps are being taken to obtain additional trucks of larger capacity, and when put into operation they will greatly relieve the present conditions. Additional space is urgently needed for the garage besides the temporary building constructed during the year to house four machines not used for freight handling. Methods of better adapting the present equipment by changes in construction, etc., are being considered and will probably be carried out during the coming year.

### Construction and Repair.

*Electrical.*—The installation of all electrical wiring, switchboards, and equipment for laboratory purposes and for maintenance of the power plant is performed by this section. Owing to the character of the research work of the Bureau the electrical work is in many cases unusually complicated, requiring very skilled mechanics. Besides the installation of the equipment, this section also repairs and extends this equipment as required. During the past year the installation of equipment in the northwest and radio buildings was practically completed. There were included in these installations several electric furnaces of large capacity, wiring of machine tools, battery installations, and many extensive additions made to the electrical work throughout the entire Bureau.

*Plumbing.*—The installation of all pipe work required for various laboratory facilities, including steam, gas, air, vacuum, water, and refrigeration, is done by the plumbing section. Here, again, owing to the nature of the equipment, which is installed for various laboratory purposes, well-trained mechanics are necessary for the pipe work to be done. The work during the past year, besides including completion of the equipment piping in the northwest and radio buildings, also covered a very large number of extensions of piping throughout the remainder of the Bureau and a very large amount of repair and maintenance work of the plant equipment. In both the electrical and plumbing sections additional help is urgently needed, and working space with adequate tools and facilities is a pressing necessity. It is possible that, in the very near future, sufficient room for a workshop for the plumbing and electrical sections will be obtainable, and such an addition should greatly increase the efficiency of these sections and improve the character of the work performed.

*Minor Construction.*—Under this section are included various small jobs of construction, such as the building of temporary structures, construction and repair of concrete roads, and repairs and alterations to existing buildings. The personnel of this section is at present entirely inadequate owing to the large number of small jobs always on hand. During the past year a temporary building was constructed for housing four automobiles, concrete roads were repaired, and about 200 feet of new roadway built of cinder concrete. Paths of cinder concrete blocks aggregating 600 feet in length were also constructed. Numerous extensions were made to the drainage system of the Bureau grounds, and the construction of retaining walls was begun. A number of repairs and alterations were also made to buildings, including partitions, skylights, painting, etc.

**Buildings and Grounds.**

*Janitors and Laborers.*—The work of this section is of more or less routine nature and comprises the cleaning of the many offices and laboratories of the Bureau and the maintaining of sanitary conditions throughout. Owing to the shifting of the laboratories, due to expansion, there was a considerable amount of moving of equipment, and in all cases where such moving was handled through this section during the past year the work was done most economically. During the past year the dynamometer and industrial buildings were practically completed, and the northwest and radio buildings, completed during the previous year, were fully occupied by laboratories. There should be a material increase in the personnel of the janitors and laborers to care efficiently for the buildings now completed.

*Guards.*—During the period of the war all of the Bureau buildings were kept under guard, and men were stationed at the entrance doors of the buildings for this purpose, as well as at the entrance to the Bureau grounds. Rigid inspection of all visitors was exercised, and only such persons as could show satisfactory reasons were permitted to enter the Bureau. Early in the year 1919 the guards were removed from the entrance doors of the buildings, but the inspection and direction of visitors is continued at the entrance of the Bureau grounds.

*Officer of the Day.*—This office was provided for the purpose of having at the Bureau at all hours some one authorized to represent the Director in all circumstances requiring the decision of a responsible officer, when the Director was not at the Bureau. The office was filled by members of the Bureau staff, each of whom was on duty for 24 hours, during which time he did not leave the Bureau. In order that this office should not work a hardship on any one person, no one was required to serve as officer of the day more than one day per month. The numerous occasions upon which this office proved to be of special advantage are conclusive evidence that the position should be permanently authorized and adequate compensation given the incumbent, inasmuch as the members of the Bureau staff have so far served as officer of the day voluntarily and without extra compensation.

*Watchmen.*—The duties of the watchmen are to make inspections of the buildings to prevent fire, theft, damage by weather, etc., to the

Bureau property. The additional buildings recently completed have added considerably to the extent of the work required by the watchmen, and, while a small addition has been made to the number of watchmen employed, the personnel of this section is still inadequate and should be materially increased for efficient inspection of all the laboratories.

*Grounds.*—The care and improvement of the grounds of the Bureau is included in the work of this section. Owing to the extensive building operations during the past year, certain portions of the Bureau grounds could not be taken care of as well as they should have been. It was also found quite difficult during the past year to obtain labor at such times as it could be used to the best advantage in maintaining the proper care of the grounds.

## 2. PHOTOGRAPHIC LABORATORY.

**[Investigation of photographic apparatus; testing of photographic materials and apparatus; standardization of testing apparatus and conditions; general photography.]**

### Sensitometer.

A sensitometer has been designed and constructed for testing the light-sensitive characteristics of plates and films. This apparatus consists of three parts: (1) The sensitometer for making accurately known exposures, (2) the thermostated developing bath, and (3) the photometer for measuring the test specimens. A circular describing this apparatus and method of testing was prepared and distributed to those interested in this work.

More than 100 tests of stained and bathed plates were made with this apparatus for the optical section. This work formed a part of a military problem in connection with the taking of photographs from airplanes, and will be found to be treated more fully under "Aerial Photography" in the report of the optical division.

### Developer Testing.

Samples of methol substitutes and other developers were tested for several Government departments.

### Photographing the Mail.

An experimental camera for photographing the mail of the Bureau has been constructed and is found to save considerable time in briefing and recording the incoming mail. This mail formerly was held in the file room until the records and brief were made, and was then delivered to the various sections of the Bureau. By the photographic method the mail is photographed on motion-picture film as soon as received and immediately delivered to the laboratories. The photographing requires from 10 to 20 minutes for the entire mail. The film negatives are projected to original size by means of a small projection lantern and the brief and file cards made. The cost is very moderate; 16 letters are copied on each foot of film.

### General Photography.

During the past fiscal year more than 2,200 miscellaneous photographic requisitions were completed. These requisitions called for photographic work of all descriptions. Much of this was in connection with the Bureau's military problems. In addition to this, the entire personnel of this Bureau (approximately 1,500) were photographed for pass and identification purposes.

# V. GENERAL RECOMMENDATIONS.

**Salaries.**

So much has been said in former reports, in the submission of estimates and the public press as to the inadequacy of salaries of scientific and technical experts in the Government service that it seems almost unnecessary to call attention at this time to a condition so well known.

The disparity existing between the salaries of these experts in the Government service and elsewhere is so great that the scientific work of the Government is rapidly being affected accordingly. It is true that the conditions existing in connection with the war have necessitated many changes in the scientific personnel of the Bureau. Nevertheless the number of changes during the past year amounts practically to 100 per cent. No work can be efficient upon that basis. Such changes are disastrous to scientific or technical work.

In submitting the estimates for the Bureau of Standards for the coming year it has been assumed that the Joint Committee on Reclassification of Salaries will thoroughly investigate this question and make recommendations accordingly. All positions, whether old or new, submitted in the estimates for 1920–21 are with the expectation that they will be adjusted by Congress to a new and adequate scale.

**Power Plant.**

The power plant of the Bureau of Standards is entirely inadequate. It now consists of the original plant constructed for two buildings and two temporary installations. These installations should be brought together under one roof in the form of a small but model power plant capable of heating the various buildings now existing, with provisions for its extension in the future. It should also provide the various electrical currents for power and experimental purposes, as well as other utilities required at the Bureau. The need for this power plant has existed for the past three or four years, but it was thought unwise to begin new construction during the war. A thorough report has been made on the situation by one of the most competent firms of consulting engineers in the country. It is estimated that such a power plant will cost in the neighborhood of $500,000. An estimate for preparing the plans and beginning the construction of the building for such a power plant will be submitted.

**Remodeling of Building for Mechanical Plant.**

The building in which are housed the instrument shops and much other construction work was the first erected at the Bureau, and has become entirely inadequate for the purpose designed. A remodeling of the roof of this building will make available an entire story. Provisions for this alteration have been requested in the former estimates and will be resubmitted for the years 1920–21.

**Additional Land.**

I would again call attention to the urgent necessity for acquiring the plot of ground between the Bureau's site and Van Ness Street on the north and that between the Bureau's grounds and Tilden Street on the south. Estimates have been submitted previously, and an appropriation was made two years ago. This, however, proved to be inadequate. A careful study has been made of the situation and an estimate will be resubmitted. It is to be regretted that, through misunderstandings and the great difficulty which always attends the purchase of real estate, these strips have not been secured heretofore, as it was evidently the intention of Congress when the appropriation was made that they should be acquired.

### Care of Buildings and Grounds.

It has been practically impossible, as well as inadvisable, to expend much money or labor upon the improvement of the grounds during the war period. Nevertheless, the time has come when a sufficient sum should be provided for the development of a simple but appropriate plan for the grounds of the Bureau of Standards and the putting of the same into effect. The appropriations for this purpose in the past have been such as to cover only a small amount of the most urgent improvements in the way of roads, walks, pipes, wires, etc. An estimate will be submitted for the purpose. It is realized that this cannot be accomplished in a single year, but the most necessary improvements should be provided for at once.

### Test-Car Depot.

Estimates will be submitted for a small building in which to house and care for the Bureau's test cars and master track scale. This building should be situated at some central place. This important service can be made more efficient by providing a small depot centrally located. Every effort has been made to handle this from Washington, but experience has shown that a small substation centrally located is necessary.

Respectfully,

S. W. STRATTON, *Director*.

To Hon. WILLIAM C. REDFIELD,
*Secretary of Commerce*.

# REPORT

OF THE

# DIRECTOR OF THE CENSUS

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DEPARTMENT OF COMMERCE,
BUREAU OF THE CENSUS,
*Washington, September 15, 1919.*

SIR: There is submitted herewith the following report upon the operations of the Bureau of the Census during the fiscal year ended June 30, 1919, and the work now in progress:

## INTRODUCTION.

The end of the fiscal year 1919 marked the close of the seven-year intercensal period during which the Bureau of the Census carried on numerous lines of statistical work at decennial, quinquennial, biennial, annual, quarterly, monthly, and semimonthly intervals, as prescribed by law; and on July 1, 1919, began the three-year decennial census period, within which time censuses of the population, agriculture, manufactures, mines and quarries, oil and gas wells, and forestry and forest products of the United States must be taken, compiled, and published.

One of the prime considerations which Congress had in mind in establishing the permanent Bureau in 1902 was the retention of a nucleus of trained officials and employees who could make their preparations for each decennial census in the light of the experience gained at preceding ones and whose familiarity with the work would be of incalculable value in supervising the collection and compilation of the census data. During the intercensal periods, however, the manifold duties of the Bureau fully justify its existence as a permanent organization.

During the fiscal year 1919 the Bureau of the Census carried on the compilation of the results of its quinquennial census of electrical industries; completed the work on its decennial inquiries relating to transportation by water and shipbuilding; brought well toward completion the preparation of its decennial report on religious bodies; completed and published its special report on marriage and divorce; conducted its annual inquiries relating to births, deaths, states, and municipalities; published quarterly statistics of stocks of leaf tobacco; made monthly and semimonthly collections and publications of statistics on cotton, cotton seed, and cottonseed products; made special enumerations of population in four counties; carried on the publication of weekly mortality reports for certain large cities; compiled statistics relating to the mortality from the influenza epidemic; performed a large amount of war work for other governmental establishments; complied with numerous requests for information; and made detailed preparations for taking the Fourteenth (1920) Decennial Census.

The work done along the above lines during the fiscal year and since its close is described below.

## CURRENT AND COMPLETED WORK ON STATUTORY INQUIRIES.

### ELECTRICAL INDUSTRIES.

Under the authority of the act creating the permanent Census Bureau, this inquiry has been made at five-year intervals since 1902. It embraces central electric light and power stations, electric railways, telephones and telegraphs, and municipal electric fire-alarm and police-patrol signaling systems.

The inquiry was made, in accordance with the usual practice of the Bureau, through correspondence so far as it was practicable to secure the data in this manner. It was necessary, however, to send a number of men into the field to obtain information which could not be secured satisfactorily by mail. The field canvass, which was made by the Bureau's permanent employees, was begun in April, 1918, and was completed in the following December, except in one State, in which two agents were employed during January, 1919, in securing reports from delinquent establishments.

A preliminary report on ocean cable systems was prepared and released for use by morning papers on November 18, 1918. Early in January, 1919, the Bureau began to issue press summaries, each giving, for a particular State or group of States, preliminary statistics for central electric light and power stations; and on April 7, 1919, this series of State summaries was completed and a summary covering the entire United States was issued. Similarly, State summaries in regard to electric railways were issued, beginning in February, 1919; and in the following April this series was completed and a summary for the entire United States was published. A supplemental statement giving figures in regard to capitalization and traffic of electric railways was given to the press under date of July 1, 1919. A preliminary report on telephones was issued in March, 1919.

Meanwhile the work on the final reports was under way. The tables and descriptive text for the light and power station report are now in process of preparation. The general tables for the electric railway report have been completed and the preparation of the text and text tables is well advanced. Tables and text for the final report on telephone lines will be sent to the printer on September 22. Copy for the final report on telegraphs, including statistics for railway telegraph and telephone lines, was sent to the printer on March 4, 1919. The preparation of the report on electric fire-alarm and police-patrol signaling systems was completed in January, 1919. This report and that on telegraphs were issued as one bulletin on July 19, 1919. A press summary of this bulletin was sent out for release on July 17, 1919.

During the canvass 71,891 schedules or reports were received. Of this number, 19,220 were secured by the field force and 52,671 (including 22,752 received through the American Telephone & Telegraph Co.) by mail.

The several electrical industries reports present information as to number of establishments, character of ownership, equipment, income, expenses, employees, salaries and wages, finances, etc.

A few of the facts brought out by the summaries already published are:

The 6,542 electric light and power stations in the United States during the year 1917 generated more than 25,000,000,000 kilowatt hours of electric energy, producing an income of over half a billion dollars and giving employment to more than 100,000 persons, whose salaries and wages aggregated nearly $100,000,000.

The 943 operating electric railways of the United States during the year 1917 transported over 11,000,000,000 fare-paying passengers, representing an average of 109 trips for each man, woman, and child in the United States; operated 102,603 cars on 32,548 miles of lines; and employed 294,826 persons, to whom were paid salaries and wages aggregating $267,240,362.

The number of telephones in use in the United States at the close of 1917 was 11,716,520—one to every 9 persons or every 2 families. Of these telephones, 7,326,858 were operated by the 145 Bell-controlled systems and the remaining 4,389,662 belonged to the 53,089 independent systems. The number of calls made during the year was estimated at 21,846,000,000—an average of more than 200 per capita.

The 21 commercial land telegraph systems in the United States in 1917 operated 241,012 miles of pole line, comprising 1,888,793 miles of wire, sent 151,725,228 messages, and employed 47,227 persons, to whom were paid salaries and wages amounting to $36,392,140.

The six ocean-cable systems of the United States operated 46,950 nautical miles of cable and transmitted 2,913,250 messages in 1917.

### TRANSPORTATION BY WATER.

The census of transportation by water is, under the law, a decennial inquiry. The work on the last such census, which covered the calendar year ended December 31, 1916, was described in my report for the fiscal year 1918. In order to avoid the disclosure of information of value to the enemy, the Secretary of Commerce had directed that the water-transportation report be not made public during the war; and for this reason, and in order to permit the employment of the census force on more pressing work, especially war work, its compilation was suspended for several months. After the signing of the armistice the report was completed and sent to the printer, and it will be ready for distribution in the near future.

This report, which will be published in a quarto volume of approximately 300 pages, will contain statistics regarding American documented and undocumented vessels or craft of 5 tons register or over, classified by geographic divisions, namely, the Atlantic coast and Gulf of Mexico, the Pacific coast, including Alaska, the Great Lakes and St. Lawrence River, the Mississippi River and its tributaries, and canals and other inland waters.

## SHIPBUILDING.

Statistics for this industry were collected in connection with the quinquennial census of manufactures covering the calendar year 1914, and a further canvass was made in conjunction with the census of transportation by water taken as of December 31, 1916. Although the results of these two investigations were compiled and the preparation of the combined report completed prior to the beginning of the fiscal year 1919, the Secretary of Commerce directed that they be withheld from publication at the time because of the inadvisability of giving out the information during the period of the war. The figures, however, were placed immediately at the disposal of the Shipping Board and other war agencies of the Government. In January, 1919, the restriction upon their publication having been removed, the manuscript was sent to the printer and the report was issued, in bulletin form, on May 16, 1919.

The statistics cover establishments engaged in the construction and repair of vessels, ships, and boats of all classes. Data for shipyards operated by the Federal Government are shown separately.

## RELIGIOUS BODIES.

The last decennial census of religious bodies covered the calendar year 1916. The collection of the data for 97 per cent of the churches was made during 1917, and for the remaining 3 per cent was completed in March, 1918. The work was done almost entirely through correspondence.

On May 2, 1918, the Bureau issued a press announcement giving preliminary figures, subject to correction, showing, by principal denominations, the numbers of church organizations, members, ministers, Sunday schools, and Sunday-school officers, teachers, and scholars; and on January 17, 1919, a second press announcement was published which embodied a revision of the first, and in addition presented statistics as to the number of church edifices, value of church property, and expenditures by religious bodies.

The report on religious bodies covers 202 denominations and will be published in 2 parts, with a total of 1,321 pages. Part I, of 594 pages, contains 14 general tables, of which 10 present statistics, by denominations, for the United States, States, counties, and cities. and 4 give statistics for those denominations composed wholly or in part of Negro organizations. In addition, this volume includes a textual discussion of the various items of inquiry, such as church organizations, church members, value of property, etc., by denominations; statistics of ministers in their relation to church work and their compensation; data as to languages used in church services; a summary of the work or general missionary, educational, and philanthropic activities of the denominations; summarized statistics of all denominations for States, counties, and cities; and a summary of the statistics for Negro organizations. Part I is now in the hands of the printer and will probably be issued in November, 1919.

Part II, of 727 pages, consists of 202 sections, each presenting a statement of the history, doctrine, polity, and work of a particular denomination, together with a brief summary and review of the principal statistics by States, and by ecclesiastical divisions where

**such divisions exist. Part II is in press and will be issued in November, 1919.**

The preparation of the religious bodies report was frequently interrupted by war work, and the printing has also been delayed by conditions arising as a result of the war.

This report shows a total of 227,487 church organizations in 1916, with an aggregate membership of 41,926,854. Of this aggregate, the Roman Catholic church reported 15,721,815 members, or 37.5 per cent. The number of Sunday schools was 194,759, with 1,952,631 officers and teachers and 19,935,890 scholars. The increase in church membership during the 10-year period 1906–1916 was 19.6 per cent, a rate slightly below that for the increase in the population of the United States between 1900 and 1910 (21 per cent).

## VITAL STATISTICS.

*Birth statistics.*—Beginning with 1915, the Census Bureau has made annual collections of birth statistics from a registration area made up of the District of Columbia and of those States having adequate birth-registration systems. This area has grown rapidly. It comprised, in 1915, only the six New England States, New York, Pennsylvania, Michigan, Minnesota, and the District of Columbia, with a total population amounting to about 31 per cent of the aggregate for the country, but embraced in 1917, in addition to the States and District just named, the States of Indiana, Kansas, Kentucky, Maryland, North Carolina, Ohio, Utah, Virginia, Washington, and Wisconsin, with a total population estimated at 53 per cent of the aggregate for the United States. No changes have been made since 1917. During the fiscal year 1919, however, tests were made in Illinois and Mississippi, but the birth registration in both States failed to measure up to the Bureau's standard of 90 per cent of completeness.

The birth statistics show, for the registration area and its subdivisions, number of births, by sex, color, and month of occurrence; births of white children, by country of birth of father and mother; total deaths (exclusive of stillbirths); births per 100 deaths; birth rates and infant mortality; deaths (exclusive of stillbirths) from important causes for 12 subdivisions of first year of life; legitimacy; plural births; ages of father and mother; and total number of children born to each mother who gave birth to a child during year covered by report, and number of surviving children.

A press summary of the birth-statistics report for 1917 was issued in June, 1919. This summary showed a total of 1,353,792 living births in the birth-registration area, representing a rate of 24.6 per 1,000 of population. The total number of deaths in the same area was 776,222, or 14.1 per 1,000. The births thus exceeded the deaths by 74.4 per cent, this excess being equal to about 1 per cent of the total population of the area. The mortality rate for infants under 1 year of age averaged 93.8 per 1,000 living births.

The report itself was completed and copy sent to the printer in July, 1919, and work is progressing satisfactorily on the report for 1918.

*Mortality statistics.*—The Census Bureau's series of mortality reports began with the year 1900. These reports have been based on data collected from States and cities in which the registration of deaths was accepted by the Census Bureau, after suitable tests, as covering at least 90 per cent of the total mortality. The death-registration area has greatly increased in size since 1900, when it contained only 40.5 per cent of the population of the country. It now comprises 31 States—the six New England States, New York, Pennsylvania, New Jersey, Maryland, Virginia, North Carolina, South Carolina, Louisiana, Mississippi, Tennessee, Kentucky, Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Missouri, Kansas, Colorado, Utah, Montana, Washington, Oregon, and California—the Territory of Hawaii, the District of Columbia, and 23 cities in non-registration States, and contains approximately four-fifths of the population of the country. The most recent additions are Illinois, Louisiana, and Oregon, admitted for the year 1918, and Mississippi, admitted for 1919.

The annual mortality report for the calendar year 1917 was completed and copy sent to the printer before the close of the fiscal year, and will be issued in November, 1919. This report shows, for the entire registration area, for the individual States, and for cities and counties, the number of deaths (exclusive of stillbirths), and it shows for States and cities the number of deaths by month of occurrence, age, sex, color, nativity and parent nativity for whites, and cause. Death rates from all causes combined and from individual causes are also given.

A press summary giving data in regard to deaths during the calendar year 1917 from all causes combined and from the principal causes separately, for the registration area as a whole, was issued June 25, 1919. The total number of deaths reported (exclusive of Hawaii) was 1,068,932, representing a rate of 14.2 per 1,000 of population. Of these deaths, nearly one-third were due to three causes—heart diseases, pneumonia, and tuberculosis—and nearly another third resulted from the following nine causes: Bright's disease and nephritis, apoplexy, cancer, diarrhea and enteritis, arterial diseases, influenza, diabetes, diphtheria, and bronchitis. Tuberculosis in its various forms, which a few years ago was responsible for more deaths than any other single cause, occupied third place in this respect in 1917, having fallen behind heart diseases and pneumonia.

*Weekly Health Index.*—The publication of the "Weekly Health Index," which was inaugurated in October, 1917, and which gives mortality reports from 46 of the largest cities of the country, has been continued. The total number of deaths reported for the week (stillbirths excluded), the death rate, the number of deaths of infants under 1 year of age, and the proportion which such deaths represent of the total are shown. During the epidemic of influenza and pneumonia additional sheets were included which gave the number of deaths resulting from those causes. Beginning with the issue for June 17, 1919, there have also been shown for each week statistics, obtained from the leading industrial insurance companies, as to number of policies in force, total number of death claims, and number of claims per 1,000 policies in force.

*Distribution of Physicians' Pocket Reference to the International List of Causes of Death.*—During the fiscal year 148,000 copies of this publication were distributed by mail to physicians, in an endeavor to reach every physician in the United States.

*Need of Federal legislation providing for registration of births and deaths.*—In the matter of birth and death registration the United States has not kept pace with many of the more enlightened countries of the world. This condition is due to the fact that registration has been left to the control of the individual State governments, many of which have failed to establish and maintain adequate systems of recording births and deaths. The practice of the Census Bureau is to admit to the " birth-registration area " those States, and to the " death-registration area " those States and those cities in nonregistration States, in which the Bureau's tests indicate the registration to represent at least 90 per cent of all births or of all deaths, as the case may be, and in which the registration systems are such as to justify the expectation of a still more nearly complete registration in the future. The present birth-registration area comprises 20 States and the District of Columbia and is estimated to contain 53 per cent of the country's population; and the present death-registration area is made up of 31 States, 23 cities in other States, the District of Columbia, and the Territory of Hawaii, with a combined population estimated at 80 per cent of the total for the country.

Thus far the only legislative action taken by the Federal Government toward the improvement of our vital statistics is found in a joint resolution of Congress approved February 11, 1903, requesting the State authorities to cooperate with the Census Bureau in securing a uniform system of birth and death registration. The Bureau itself has achieved some success in arousing the interest of the States in the matter. Under present conditions, however, it is likely to be many years before the last one of the 48 States enacts and properly administers adequate registration laws. It will thus be necessary, if the birth and mortality records of every municipality and county are to be made reliable, permanent, and readily available for reference at any time in the near future, to provide for a comprehensive system of Federal control and supervision. I recommend, therefore, that this be done.

### FINANCIAL STATISTICS OF CITIES.

The report presenting financial statistics of cities having more than 30,000 inhabitants for the fiscal year 1918 was completed and copy sent to the printer on March 17, 1919, and will be issued in October, 1919. This report is one of an annual series which was inaugurated when the Bureau of the Census became a permanent organization in 1902. It is a 357-page quarto volume giving statistics in regard to (1) total and per capita receipts from the various sources of revenue; (2) total and per capita payments for expenses, interest, and outlays; (3) total value of city properties; (4) total and per capita indebtedness, purpose of issue, and rate of interest; and (5) assessed valuation of property, basis of assessment, tax levies, rates, and methods of assessment. The figures for each city relate to its latest fiscal year ended prior to July 1, 1918. In addition to the financial statistics just specified, the report presents various other items of information of interest to municipal officials, members of civic bodies, etc.

A press summary of the report for the fiscal year 1918 will be issued in October, 1919. Among the more important of the facts that will be set forth in this summary are the following: In 147 of the 227 cities of more than 30,000 population, the excess of expenditures for governmental costs, including interest and outlays for permanent improvements, over revenues during the fiscal year amounted to $70,923,990, or $3.48 per capita. In the remaining 80 cities the excess of revenues over expenditures was $22,323,060, or $1.60 per capita. Taking the entire 227 cities as a group, the excess of expenditures over revenues amounted to $48,600,930, or $1.42 per capita.

The field and office work on the 1919 inquiry is now in progress, and copy for the report will probably be sent to the printer early in the spring of 1920.

### GENERAL STATISTICS OF CITIES.

It has been the practice of the Census Bureau, since its establishment on a permanent basis in 1902, to issue reports on various phases of municipal governmental activities, in addition to the financial reports, under the title "General Statistics of Cities." At first these general statistics were issued biennially, but for the fiscal years 1915 to 1918, inclusive, they have been published annually. For 1918 the subject covered under this head was municipal markets in cities of over 30,000 population. Copy for the report was transmitted to the printer January 31, 1919; on May 12 a press summary was issued; and on July 23 the complete report was published in the form of a 56-page bulletin. This report showed a total of 237 municipal markets maintained by 128 of the 227 cities having more than 30,000 inhabitants. (Many of the smaller cities also maintain markets, but since the Bureau is authorized by law to collect statistics only from those having more than 30,000 inhabitants, it was impossible to extend the inquiry so as to cover the entire field.)

Although the municipal market is by no means a new institution, it has received a great impetus in recent years. In fact, no fewer than 107 of the 237 markets covered by the report have been established since the beginning of the present century, and 67 have commenced operations since January 1, 1914. The subject is a timely one in view of the abnormally high prices now charged for most foodstuffs, and the information presented in the report will be of value to cities that have not yet established municipal markets but are contemplating doing so.

Early in the fiscal year two reports—"Specified Sources of Municipal Revenue: 1917," and "Statistics of Fire Departments: 1917"—which had been prepared during the preceding fiscal year were published.

Because of the necessity for curtailing its current inquiries in order that the Bureau may have available for the Fourteenth Census work a sufficient number of trained employees, no report giving general statistics of cities will be compiled for the fiscal year 1919.

### FINANCIAL STATISTICS OF STATES.

The report presenting financial statistics of States for the latest fiscal year was completed and copy was sent to the printer on April 19, 1919, and was issued in September, 1919. The report on this subject is the fourth of the annual series of which it forms a part. It follows closely the lines of the reports giving financial statistics of cities, showing in detail State revenues, expenditures, properties, indebtedness, assessments, tax rates, etc. In fact, the only changes made in the municipal classifications in adapting them to the State reports consist in the addition of items showing certain functions exercised by State governments that do not generally pertain to municipal governments.

A press summary of the report for the fiscal year 1918 was issued under date of August 4, 1919. Among the more important of the facts set forth in this summary are the following: In 30 of the 48 States the revenues exceeded the expenditures for governmental costs, including interest and outlays for permanent improvements, by $37,417,163, or 55.5 cents per capita; but in the remaining 18 States the revenues fell below the expenditures by $14,597,449, or 40.5 cents per capita. Taking the entire 48 States as a whole, the excess of revenues over expenditures was $22,819,714, or 22.1 cents per capita.

Work on the inquiry for the fiscal year 1919 is now in progress, and the copy for the report will probably be sent to the printer early in the spring of 1920.

The State finance reports, which present the only statistics that permit comparison of the revenues, expenditures, and other financial transactions of State governments, have been well received by the State officials, and as a result of the inauguration of this inquiry proper accounting systems have already been adopted in certain States which had not formerly maintained them.

### COTTON AND COTTON SEED.

During the fiscal year the Census Bureau carried on its regular inquiries relating to cotton and to cotton seed. In addition to an annual bulletin on cotton production and distribution for the season of 1917–18 and a pamphlet giving complete statistics of cotton ginned from the crop of 1918, there were issued 10 reports relating to cotton ginned to specified dates during the ginning season; 12 reports, at monthly intervals, on cotton consumed, imported, exported, and on hand, and active consuming cotton spindles; and another monthly series relating to cotton seed received, crushed, and on hand, and cottonseed products manufactured, shipped out, and on hand.

The annual bulletin presents the statistics published in the periodical reports for the preceding year, with additions and amplifications, together with data relative to cotton production and consumption in foreign countries and other information in regard to the cotton and cottonseed-products industries. The pamphlet presenting the final figures on cotton ginned from the crop of 1918 (together with data for earlier years) was distributed in time to be of use in making comparisons between the ginnings from the crop of 1919 and those for corresponding periods in preceding years. The periodical and monthly reports on cotton ginned, cotton consumed, cotton seed and its products, etc., are issued in the form of post cards, which are mailed to large numbers of growers, ginners, manufacturers, dealers, and others interested in the cotton and cottonseed industries.

The extension of cotton growing southward into Florida has necessitated the establishment of new ginneries. The Bureau has accordingly sent circular letters to some 300 postmasters in that section in order to obtain the names of all ginneries established, so that complete information as to cotton ginning in Florida may be collected.

The pamphlet giving statistics in regard to the 1918 cotton crop showed a production of 12,040,532 equivalent 500-pound bales, gross weight. This crop was greater than the crops of the preceding 3 years, but was somewhat below the averages for the last 5 years and the last 10 years—12,423,917 bales and 12,728,576 bales, respectively. The production in all the cotton States except Texas, Louisiana, Oklahoma, and Florida showed an increase as compared with 1917.

### STOCKS OF LEAF TOBACCO.

During the fiscal year the Bureau issued four reports on stocks of leaf tobacco held by certain classes of manufacturers and dealers coming within the scope of the act of Congress approved April 30, 1912. These reports related to the dates July 1 and October 1, 1918, and January 1 and April 1, 1919.

In addition, Bulletin 139, entitled "Stocks of Leaf Tobacco: 1918," was prepared within the fiscal year. It presents the data contained in the quarterly reports just mentioned, together with comparative figures for earlier years and various statistical information in regard to production, consumption, imports, and exports; prices paid growers; kinds and quantities of products; Federal revenue derived from tobacco, etc. Data relative to the world's production of tobacco and the international trade in unmanufactured tobacco are also shown. This bulletin is the second of an annual series designed for the purpose of bringing together in convenient form for ready reference the statistics of the various phases of the tobacco industry published by the several Federal bureaus which compile such statistics.

### OFFICIAL REGISTER.

One of the duties imposed by law upon the Census Bureau is the compilation of the Official Register of the United States. This is a biennial publication which gives the name, position, salary, etc., of every official and employee in the legislative and judicial branches of the Federal Government; of every official and employee in the civil service of the executive branch, exclusive of the postal service; and of every commissioned officer of the Army, Navy, and Marine Corps. The forthcoming issue will relate to July 1, 1919. Preparations for the compilation of this issue were made during the latter part of the fiscal year 1919, and the work is now well under way. The last edition, that for July 1, 1917, contained about 166,000 names, but the number in the edition for the present year will be very much greater.

## SPECIAL AND MISCELLANEOUS LINES OF WORK.

### MARRIAGE AND DIVORCE.

Marriage and divorce statistics for the calendar year 1916 were collected in 1917. At the close of the fiscal year 1917–18 the work on the report had been substantially finished with the exception of the text and text tables, which were completed in August, 1918. A press summary was issued March 20, and the report itself was published April 7, 1919. The work of compilation and preparation for printing was delayed somewhat by the necessity of employing clerks on the various war inquiries that were carried on by the Bureau, and the printing was also delayed by the rush of war work at the Government Printing Office.

The report on marriage and divorce shows, among other things, by counties, the number of marriages performed and the number of divorces granted during 1916, with detailed statistics for divorces, covering such matters as cause, party to whom granted, whether contested, place of marriage, whether alimony was asked and whether granted, and the extent to which children were affected.

### SPECIAL CENSUSES OF POPULATION.

Special censuses of the population of Okmulgee, Ottawa, and Tulsa Counties, Okla., were ordered by the Secretary of Commerce at local request and expense. The census of Okmulgee County was taken as of August 15, 1918, and the report published in January, 1919; the census of Ottawa County was taken as of December 16, 1918, and the report published February 27, 1919; and the enumeration of Tulsa County was made as of January 15, 1919, and the report issued April 25, 1919.

A special census of Charles County, Md., was ordered by the Secretary of Commerce in March 1919, at the request of the Secretary of the Treasury, in order to determine its population and the effect of the recent influenza epidemic thereon. The schedules and instructions for this special census were prepared in conjunction with Dr. Frost, of the Public Health Service. The enumeration was made as of March 12, under the supervision of experienced census employees, but the tabulation of the returns was made by the Public Health Service.

### STATISTICS OF FATS AND OILS.

Early in the calendar year 1919 the collection, at monthly intervals, of data in regard to the production, consumption, and stocks of fats and oils was discontinued by the Food Administration, its last compilation of such data being that for December, 1918. In view of the need for reliable information concerning these commodities during the reconstruction period, the Secretary of Commerce authorized the Bureau of the Census to collect and publish, at quarterly intervals during the calendar year 1919, statistics similar to those which had been gathered and compiled by the Food Administration. The required forms were printed and sent out, and the compilation of the statistics is now under way.

### UNITED STATES LIFE TABLES.

As stated in my previous reports, the Bureau of the Census compiled a series of "life tables" based on the population in 1910 and the mortality in the three years 1909, 1910, and 1911 for the six New England States and New York, New Jersey, Indiana, Michigan, and the District of Columbia. These life tables, which were published in June, 1916, are similar to those prepared by most civilized countries, but differ from those used by life insurance companies in that they relate to the entire population of the area covered instead of being confined to selected risks. In order to provide a basis for the study of changes in mortality conditions, life tables were computed for these same areas for the three-year period 1900–1902, and in addition certain tables for the ten-year period 1901–1910, and two for the census year 1890 for Massachusetts, the only State for which data for that year were available. These supplementary tables, with their accompanying text, will be sent to the printer in November, and will be included in a new edition of the original life tables, thus materially enhancing the value of the latter. In connection with certain of the original tables there will be given in this new edition commutation columns, annuities, and premiums at various rates of interest; and there will be shown also the data on which the various tables were based, together with the derivation of the theory and an explanation of the methods of computing them. The preparation of these tables could not be brought to completion sooner without interfering with the current work of the bureau; but their character is such that their value is not impaired in any material degree by the delay in publication.

### SPECIAL INVESTIGATION OF INFLUENZA EPIDEMIC.

The sudden outbreak of influenza and pneumonia in the United States early in the fall of 1918 took so great a toll of life that it was felt by eminent medical men and vital statisticians throughout the country, including officials of the United States Public Health Service, that such data in regard to the mortality resulting from these causes as were obtained by the Bureau of the Census from the death-registration area would be of great value in studying the epidemic if compiled in special tables. The Director of the Census therefore authorized the immediate compilation of these data. Special tables and diagrams showing the deaths from influenza and pneumonia in Indiana, Kansas, and the city of Philadelphia, from September 1 to December 31, 1918, are now ready for publication in the form of a special bulletin.

Thanks are due to the United States Public Health Service for its generous financial assistance in this work.

### STANDARD NOMENCLATURE OF DISEASES, PATHOLOGICAL CONDITIONS, AND INJURIES.

The preparation of a standard nomenclature of diseases, pathological conditions, and injuries for the United States was begun by the Council of National Defense during the war, but it became necessary to lay it aside because of the pressure of other important work. The council thereupon turned it over to the Bureau of the Census, with the approval of the Surgeon Generals of the Army, Navy, and Public Health Service, and the Bureau completed the work and sent the copy to the printer before the close of the fiscal year.

### INTERNATIONAL STATISTICAL YEARBOOK.

Within the past fiscal year the Bureau was requested by the Secretary of the International Statistical Institute at The Hague to supply data relating to the United States for the International Statistical Yearbook (Annuaire Internationale de Statistique), published by the Institute. Compliance with this request involved considerable work, as figures were called for in detail not only for the United States as a whole but for each State as well; but, since the yearbook will be a standard publication presenting statistics for all the countries of the world, and will be very widely used, it seemed desirable and important that the figures for the United States should be as nearly complete as it was possible to make them. The work was begun in February, 1919, and was completed in June, 1919.

### STATISTICAL DIRECTORY OF STATE INSTITUTIONS.

During the fiscal year 1918 the Bureau brought to substantial completion the compilation of a statistical directory of State institutions for the dependent, defective, and delinquent classes, of which mention has been made in my preceding reports. Because of the great amount of war work and other current work to be done both by the Printing Office and by the Bureau, the publication of this directory has been considerably delayed, but it is expected that it will be ready for distribution before the close of the present calendar year.

### SEARCHING OF CENSUS RECORDS TO DETERMINE AGES.

During the fiscal year 2,315 searches of census records were made for the Pension Bureau in order to determine the ages of applicants for pensions and increases of pensions. Many other searches were made for genealogical purposes and for the purpose of supplying statements as to the ages of children whose births had not been recorded and who wished to obtain certificates showing that they were of suitable ages to permit their employment without violation of the child-labor laws. In addition, as set forth in the section entitled "War Work," much work was done in searching the records to establish the ages of men who had not registered for military service but were believed to be within the prescribed ages.

### DISTRIBUTION OF OLD CENSUS SCHEDULES TO STATE LIBRARIES.

The Census Bureau had on hand 1,349 bound volumes of old schedules returned by the enumerators at the censuses of 1850 to 1880, containing data relating to births and deaths, agriculture, manufactures, and "social statistics of cities." As these volumes were of little value to the Bureau for genealogical or other purposes and were rarely used or referred to, and as the storage space in the fireproof vault at the Commerce Building was needed for other material, it was decided to dispose of them. Accordingly they were distributed during the year to State libraries and historical societies, and in cases where the State officials declined to receive them, to the library of the Daughters of the American Revolution, at Washington.

### MISCELLANEOUS INFORMATION SUPPLIED OTHER GOVERNMENTAL AGENCIES AND OUTSIDE ORGANIZATIONS.

Numerous compilations of statistical information from the Bureau's records were made in compliance with requests received from other Federal bureaus and offices and from private concerns. The more important of these compilations are set forth below.

*Chamber of Commerce of the United States.*—List of cities of 10,000 to 15,000 population which reported municipal lighting systems at the last census of electrical industries.

*United States Tariff Commission.*—Table showing, by States, quantities and values of certain classes of woven goods reported as manufactured in 1914; list of establishments engaged in production of bone, carbon, and lampblack.

*War Department, Office of Surgeon General.*—Table giving statistics for inland waterways, showing principal ports and numbers, sizes, and ownership of, and quantities of freight handled by, the various classes of vessels on canals and inland waters.

*General Electric Co.*—Statistics showing growth of central electric light and power station industry since 1912.

"*Power Plant Engineering*" (*periodical*).—Data showing, by States, horsepower reported by central electric light and power stations and electric railways for 1917 and by manufacturing establishments for 1914.

*Sinclair Refining Co., Chicago.*—Statistics showing, by States, power-plant equipment of central electric light and power stations and electric railways; and, for the United States as a whole, distribution of power between light and power stations and electric railways.

*Southwestern Electrical and Gas Association, Dallas, Tex.*—Statistics relating to the States of Louisiana and Texas, and the United States as a whole, as to capital, income, employees, customers served or passengers carried, and output of stations, as reported by electric light and power companies and electric railways for 1917 and by gas companies, so far as such statistics were available, for 1914.

*National Association of Cotton Manufacturers.*—Statements showing stocks of cotton lining and of cloth and fabric for uppers held by boot and shoe and leather manufacturers at close of each month from May 31 to December 31, 1918, and on March 31, 1919.

## WAR WORK.

### WORK DONE BY THE BUREAU OF THE CENSUS FOR OTHER GOVERNMENTAL ESTABLISHMENTS.

During the fiscal year the Bureau of the Census carried on various lines of war work, most of which were begun during the preceding year, for the War Department and for other Federal establishments. The more important of these activities are briefly described below.

*Census of materials and commodities for use of war agencies.*—This work, which was authorized on April 8, 1918, is referred to on pages 11 and 12 of my report for the fiscal year 1918. It was undertaken for the purpose of securing statistical information needed by a number of war agencies—the War Trade Board, the War Industries Board, the Shipping Board, the Food Administration, the Council of National Defense, and the Commercial Economy Board—

in regard to the production and stocks on hand of the following-named classes of commodities, which are listed in the order in which the work upon them was taken up:

Kapok fiber.
Jute.
Leather stocks.
Boots, shoes, and manufactured leather goods.
Silk.
Antimony.
Graphite crucibles.
Wool manufactures—machinery and production.
Iron and steel products.

For stocks of kapok fiber, one report, relating to the date May 1, 1918, was compiled from the returns of 313 establishments. This report was prepared and given to the war boards prior to the beginning of the fiscal year 1919, but considerable work was afterward done in revising the statistics for final presentation.

For stocks of jute, one report, referring to June 1, 1918, was compiled from the returns received from 3,473 establishments. This was completed and given to the war boards on October 2, 1918.

For leather stocks, monthly reports relating to the last day of each month, May to December, 1918, and quarterly reports relating to March 31 and June 30, 1919, have been compiled. The first of these reports, which was given to the war boards on August 28, 1918, was based on the returns from 3,266 establishments for May 31, and was followed in rapid succession by reports for the following months. The Bureau also issued press summaries giving statistics for leather stocks in the United States, together with figures for the quantities and values of imports and exports of leather, as compiled by the Bureau of Foreign and Domestic Commerce, for the periods intervening between the dates to which the reports related.

For stocks of boots, shoes, and manufactured leather goods, reports similar in form to those compiled for leather stocks were prepared and given to the war boards and other agencies, and summaries were given to the press. These reports related to the last day of each month, June to December, 1918, and to March 31 and June 30, 1919. The report of stocks on hand and in transit for June 30, 1918, was based on returns received from 3,541 establishments and was given to the war boards on October 18, 1918.

Although the collection of statistics for leather stocks and stocks of boots, shoes, and manufactured leather goods ceased to be a war necessity after the signing of the armistice, it was of great importance as a conservation measure. The collection of these statistics, at quarterly intervals, was therefore continued until the end of the fiscal year 1919, at the request of the War Industries Board and upon the recommendation of the War Service Committee representing the shoe and leather industries of the United States Chamber of Commerce. It was decided that a simplified form of schedule should be used for the quarterly statistics, which would answer all requirements and at the same time lessen the work of the Bureau as well as that of the persons supplying the data; and accordingly the form in use was revised and a new schedule printed.

The silk report, which related to June 1, 1918, and covered returns for 1,588 establishments, was given to the war boards on October 7, 1918.

The antimony report related to June 30, 1918, and was based upon the returns from 751 establishments. This report was completed and given to the war boards on October 8, 1918.

For graphite crucibles reports were prepared relating to the dates June 30 and September 30, 1918. The first canvass covered 938 establishments, and the preliminary and final reports were given to the war boards on September 5 and September 30, 1918, respectively. The report for September 30, covering 828 establishments, was completed and given to the war boards on January 25, 1919.

The canvass for woolen manufactures and wool machinery related to July 1, 1918. A preliminary report, based upon the returns from 900 establishments, was given to the War Industries Board on August 7, 1918; and the revised report, covering 1,074 establishments, was completed and given to the war boards and other governmental agencies on September 6, 1918. A condensed table summarizing the results of this inquiry was also prepared, and mimeographed copies were sent on November 21 to the National Association of Wool Manufacturers for distribution among its members.

The canvass for iron and steel products referred to September 1, 1918. A preliminary tabulation, covering 7,129 establishments, was made and submitted to the war boards under date of October 30, 1918; and returns received later, up to and including November 23, were tabulated and the results included in a revison of this advance report, which was given to the statistical branch, General Staff, War Department, on November 29, 1918. The final report, covering 10,494 establishments, was completed and supplied to the war boards on December 23, 1918.

Statistics for all the war commodities covered by the several inquiries have been revised and rearranged for printing in a somewhat condensed form more convenient for reference. This is designed to be the final presentation of these statistics, which will constitute a permanent record of the census of war commodities.

The bulk of the work on these war-commodities inquiries was done during the period from May 1 to November 30, 1918; and the total number of questionnaires handled in connection with the compilation of the statistics was 204,596.

*Census of commercial greenhouses.*—This inquiry, which was made at the request of the priorities division of the War Industries Board, in order to obtain information for use in connection with fuel restrictions, was authorized by the Secretary of Commerce on July 13, 1918. The work performed consisted in gathering, by means of questionnaires, data pertaining to commercial greenhouses, covering, for the year ended June 30, 1918, area; value of products; fuel, fertilizers, insecticides, and fungicides used; and the number of men 18 years of age and over continuously employed. The work was done during the period from July 24 to November 30, 1918, and the total number of schedules handled was 29,192.

*Work done for Provost Marshal General.*—As stated in my former report, the Bureau, at the request of the Provost Marshal General, allocated the enlistments in the Navy, the Naval Reserve, the National Naval Volunteers, and the Marine Corps from April 2, 1917, to June 30, 1918. These enlistments, which numbered 293,788, were allocated in anticipation of their being credited to the quotas of the various States, in accordance with the terms of the bill providing for the second draft, as passed by the House of Representatives. This provision, however, was rejected by the Senate and was stricken out in conference.

Estimates were prepared in July, 1918, for the Provost Marshal General, as to the number of British subjects in the United States who might be subject to draft under the terms of the conventions concluded between this country and Great Britain, and also as to the number of men in the United States from 18 to 20 and from 21 to 45 years of age, inclusive.

*Determination of ages of registrants.*—District attorneys and other officials of the Department of Justice were, at their request, supplied with age certificates for men who, although of military age, had not registered for the selective draft. Such certificates have been furnished from month to month during the entire fiscal year and since its close, and some of the cases are still pending.

Men who were in doubt as to whether they were within the military age limits were supplied with statements as to their ages.

*Liberty loan work.*—In connection with the Liberty Loans made during the fiscal year the Bureau of the Census rendered aid to the Treasury Department by sending out literature to various mailing lists.

*Compilation of statistics relative to foreign countries for peace conference.*—This compilation comprised statistics of the movement of cereals, salt, oil, coal, and wood on the railways and waterways of Russia in 1908, 1909, and 1910, the latest years for which figures were available; a tabulation showing the distribution of manufacturing establishments and wage earners in Austria by industries and factory inspection districts; and statistics in regard to the exports and imports of countries and colonial possessions in Africa.

*Information for United States Shipping Board.*—At the request of the United States Shipping Board, detailed tables were prepared showing the population and value of agricultural products within a radius of 100 miles of each of 28 cities, located on the Atlantic, Pacific, and Gulf coasts.

*Miscellaneous war work.*—In addition to the specific lines of work just described, the Census Bureau performed numerous small amounts of war work for various departments and establishments of the Government, including the Post Office Department, the Navy Department, the Department of Labor, the Bureau of Foreign and Domestic Commerce, the Fuel Administration, the Federal Trade Commission, the Telephone and Telegraph Administration, the Office of the Chief of Engineers, the General Engineer Depot, the Office of the Director of Military Aeronautics, the Emergency Fleet Corporation, the Railroad Administration, the War Industries Board, the War Trade Board, the Capital Issues Committee, the Central Statistical Clearing House, the Employment Service, the Reconstruction Survey, the War Service Committee of the Rubber Industry of the United States, and the American Electric Railway Association War Board.

The total amount of war work done during the fiscal year (exclusive of overtime) was equivalent to the services of 1,719 employees for one month, or 143 for one year. Most of this service, of course, was performed prior to January 1, 1919.

### ENLISTMENTS, CONTRIBUTIONS, ETC.

*Members of Bureau's force enlisted and drafted into military and naval services.*—During the fiscal year 25 office and field employees of the Census Bureau entered the military and naval services (not including those who joined as Army field clerks). The total number who entered those services from the outbreak of the war to the signing of the armistice was 79. The loss of so many employees, some of whom had had years of experience in census work, caused considerable inconvenience, but no effort was made to obtain deferred classification for any of these men because of their employment in the Bureau. Up to August 31, 1919, only 20 of the 79 men who left had returned to the Bureau.

*Subscriptions for war purposes.*—Subscriptions made by the Census officials and employees to the Fourth Liberty Loan and the Victory Loan—the two loans made during the fiscal year—totaled $190,800 (not including subscriptions of local cotton agents), and the aggregate subscriptions to the five war loans amounted to $355,600. The proportions which the numbers of subscribers represented of the total force of the Bureau were 77.4 per cent at the first loan, 75.6 per cent at the second, 89 per cent at the third, 96.2 per cent at the fourth, and 98.4 per cent at the Victory Loan. The total sales of War Savings Stamps and Thrift Stamps in the Bureau, to August 31, 1919, aggregated $23,620. In addition, the members of the Census force subscribed $4,551 to the Red Cross; $4,648 to the United War Work Campaign, etc.; and $3,000 for the support of French war orphans.

During the entire period of the war the Bureau's personnel manifested a high spirit of patriotism and a most commendable degree of self-sacrifice.

## PREPARATIONS FOR THE FOURTEENTH CENSUS.

### THE FOURTEENTH CENSUS LAW.

As set forth in my report for the fiscal year 1918, a bill to provide for the fourteenth and subsequent decennial censuses was drafted by the Census Bureau and submitted to the House Committee on the Census. The bill was passed by the House of Representatives July 2, 1918, and by the Senate, with amendments, January 14, 1919; the conference report was adopted by the Senate February 28, 1919, and by the House March 3, 1919; and the bill was approved by the President March 3, 1919. The act as enacted did not differ greatly from the bill prepared by the Census Bureau, although a number of minor changes were made. In many respects it follows the lines of the Thirteenth Census legislation, but there are departures in regard to a few important features and numerous unimportant ones. The most significant points of difference are as follows:

*Section 1.*—Provision for census of forestry and forest products.

*Section 6.*—Reclassification of clerical salaries, increase in compensation of clerical and subclerical employees, and increase in number of higher-salaried clerks in Census Bureau; and provision for preference to honorably discharged soldiers, sailors, and marines, and widows of such, in making appointments to clerical and other positions in all executive departments and independent governmental establishments. The reclassification of clerical salaries provides a much larger number of classes, differing from each other by only $60 per annum between $900 and $1,440, and by $120 per annum between $1,440 and $1,800. The provision for preference to honorably discharged soldiers, etc., was later amended by section 1 of the third deficiency appropriation act, approved July 11, 1919, to make it apply to all positions in the executive branch of the Government in the District of Columbia and elsewhere, and to include the wives of injured soldiers, sailors, and marines who themselves are not qualified, but whose wives are qualified, to hold the positions to which appointments are contemplated.

*Section 7.*—Provision requiring Civil Service Commission to examine applicants who are temporarily absent from the places of their legal residence without requiring them to return for the purpose of taking the examination, and provision authorizing selection of temporary census employees from reemployment registers established by Executive order of November 29, 1918. The first-mentioned provision is general legislation relating to the entire Government service. The reemployment registers established by Executive order of November 29, 1918, are made up of the names of persons eligible for permanent employment in apportioned positions in the competitive classified service who have been separated from competitive classified positions after less than three years' service, by reason of reductions of force, and who have been recommended for further employment by the Government because of efficient service.

*Section 8.*—Omission of provisions for securing information in regard to unemployment on census date and during preceding calendar year and in regard to survivors of Union or Confederate Army or Navy. The information obtained through these inquiries at the Thirteenth Census was incomplete and unsatisfactory, for which reason it was decided to drop them.

Insertion of provision for obtaining information as to encumbrances on homes and farms.

Omission of provision for enumeration of inmates of institutions for dependent, defective, and delinquent classes. The inquiry relating to these classes will be made after the close of the Fourteenth Census period.

Inclusion of inquiry as to sex of farm operators.

Amplification of irrigation inquiry and addition of drainage inquiry.

*Section 9.*—Provision for appointment of supervisors by Secretary of Commerce, upon recommendation of Director of the Census, instead of by President, by and with advice and consent of Senate.

*Section 20.*—Change of census date from April 15 to January 1; reduction of minimum-size limit for cities in which enumeration must be completed within two weeks from 5,000 to 2,500 (as ascertained at last preceding census).

*Sections 21–24.*—These, the so-called "penalty sections," have been so drawn as to make them more effective and more readily enforceable than the corresponding sections of the Thirteenth Census act. In section 23 there has been inserted a provision penalizing the offering of any suggestion, advice, or assistance by any individual, committee, or other organization, with the intent or purpose of causing an incorrect enumeration to be made.

*Section 31.*—Provision for mid-decennial census of agriculture to be taken in 1925 and at ten-year intervals thereafter. (A similar provision was included in the Thirteenth Census act, but was later repealed.)

*Section 32.*—Provision for biennial census of products of manufacturing industries, beginning in 1921.

These provisions for more frequent canvasses to ascertain the character and extent of our agricultural and manufacturing resources represent a most important extension of the Bureau's work and one which, I am confident, will achieve results of real benefit to the country. Hitherto these inquiries have been made at intervals of such length—ten years for agriculture and five years for manufactures—that they have not at all times provided the data needed by agricultural and industrial interests, by legislators, and by the public generally. For example, the present campaign to reduce the cost of living could be carried on more efficiently, and those in charge of it could proceed with a greater degree of certainty, if we had up-to-date figures as to agricultural and manufactured products. And, apart from the abnormal conditions now existing, the complexity of the present-day industrial fabric is such as to require more frequent statistical illumination if it is to be maintained in a condition of strength and soundness.

### JOINT ADVISORY COMMITTEE OF AMERICAN STATISTICAL AND ECONOMIC ASSOCIATIONS.

Upon the invitation of the Secretary of Commerce, under date of November 18, 1918, the presidents of the American Statistical and American Economic Associations appointed a joint committee to be advisory to the Director of the Census and the Department of Commerce in connection with the work of the Fourteenth Census. This committee is composed of six members, namely:

Representing American Statistical Association—

W. S. Rossiter, chairman, formerly chief clerk, Bureau of the Census; now president, Rumford Press, Concord, N. H.
Prof. Carroll W. Doten, Massachusetts Institute of Technology.
Dean Edwin F. Gay, Harvard University.

Representing American Economic Association—

Prof. Wesley C. Mitchell, Columbia University.
Prof. E. R. A. Seligman, Columbia University.
Prof. Walter F. Willcox, Cornell University.

The Joint Advisory Committee has thus far held six meetings, the first on February 10, 1919, and the sixth on June 27, 1919. It has given very careful consideration to all phases of the census work in connection with which plans have thus far been made, has given its approval to practically all these plans, and has made a number of helpful recommendations. I take this opportunity to express publicly my sincere thanks to the members of this committee for the assistance they have rendered to me and to the other officials of the Bureau in making our plans for the great task of taking the Fourteenth Census.

### FIELD FORCE.

Continental United States (exclusive of Alaska) has been divided into 372 supervisors' districts. These districts, outside the large cities, are, as a rule, coextensive with the congressional districts; but each of the large cities has been placed under the charge of a single supervisor, with the exception of New York City, which has been divided into four districts. A bulletin describing the supervisors' districts and showing their outlines on a series of State maps has been prepared and printed; and tentative plans for the division of these districts into approximately 85,000 enumeration districts have been prepared for the use of the supervisors. In order to secure the data needed as a basis for this work, it was necessary to send letters to the 3,050 county clerks throughout the country requesting information as to changes in the boundaries of the counties and their subdivisions since 1910, and to obtain from the officials of the 779 cities which at the last census had populations of 8,000 or more, maps showing ward and precinct boundaries and statements of the registration at the latest elections.

As already pointed out, the Fourteenth Census act provides for the appointment of supervisors of census by the Secretary of Commerce, upon the recommendation of the Director of the Census. This is a departure from the method employed heretofore, namely, appointment by the President, by and with the advice and consent of the Senate, which naturally might occasion more or less delay in certain cases, especially because of the change in the census date. At the Thirteenth Census the enumeration was made as of April 15, and at earlier censuses as of June 1; but under the existing law the next and subsequent censuses will be taken as of January 1. This necessitates the appointment of the supervisors at an earlier date than heretofore, and with the least possible delay. Moreover, it is believed that the director will have more direct control over the supervisors and thus can obtain better results under the method of appointment provided for in the Fourteenth Census act.

Under date of March 17, 1919, the Bureau issued a press notice setting forth the date of the coming census, the approximate number of supervisors to be appointed, and the method of their appointment, and requesting applicants for supervisorships to address their applications to the Director of the Census. Approximately 5,500 persons were supplied, upon request, with application blanks for the position of supervisor, similar to the forms used by the Civil Service Commission for "nonassembled" examinations. About 2,200 of these applications were filled out and returned to the Bureau, duly sworn to. A suitable scheme of rating was devised, the papers were graded accordingly, selections were made, and a list of candidates recommended to the Secretary of Commerce for appointment; and during August practically all the appointments were made by the Secretary and announced through the public press.

Of the 372 supervisors appointed for continental United States, 65, or 17.5 per cent, were in the military or naval service during the recent war. Three women have been appointed, one each in New York, Texas, and Nevada. In the following statement the supervisors are grouped according to certain of the more important occupations represented:

| Occupation. | Number. | Per cent. |
|---|---|---|
| Total | 372 | 100.0 |
| Lawyers | 110 | 29.6 |
| Physicians and dentists | 5 | 1.3 |
| Editors | 44 | 11.8 |
| Educators | 13 | 3.5 |
| Farmers | 23 | 6.2 |
| All other | 177 | 47.6 |

The following letter from the Secretary of Commerce addressed to me, under date of July 12, 1919, in regard to political activity on the part of supervisors and enumerators, has been embodied in the instructions to these classes of census employees:

> The taking of the Fourteenth Census involves the appointment of some 400 supervisors, upon whom in turn will rest the serious duty of selecting and appointing many times that number of enumerators. The success of the census will depend upon the efficiency, impartiality, and the strict attention to duty of the supervisors and upon the intelligence of the enumerators and their faithful devotion to the important public business which is to be placed in their hands.
>
> The vast country-wide system thus created can be perverted to political uses if both supervisors and enumerators are not forbidden to use it as an instrument for influencing either local or general elections, or primaries, in the interest of particular candidates or parties.
>
> The work of the census itself is a sufficient task to tax the powers of those concerned in it, and it is a reasonable requirement that whoever accepts an appointment as supervisor or enumerator shall during the term of his employment as such strictly avoid any active part in politics.
>
> Attention is therefore directed to the following order of the President of the United States, dated August 14, 1909:
>
> > "I therefore order that, in the preparation of regulations for the taking of the census, you and the Director of the Census embody therein a provision that any supervisor or enumerator who uses his influence with his subordinates or colleagues to assist any party or any candidate in a primary or general election, or who takes any part, other than merely casting his vote, in politics, national, State, or local, either by service upon a political committee, by public addresses, by the solicitation of votes, or otherwise, shall be at once dismissed from the service.
> >
> > "I wish to make this regulation as broad as possible, and wish it enforced without exception. It is of the highest importance that the census should be taken by men having only the single purpose of reaching a just and right result, and that the large amount of money to be expended in the employment of so vast a machine as the census shall not be made to serve the political purposes of any one."
>
> The above order, applicable to the census of 1910, is now confirmed and made applicable to the work of the census of 1920. It is an essential factor in the appointment of every supervisor and enumerator and is to be obeyed by those officers in letter and in spirit. Departure from it will be considered as warrant for dismissal from the service, as therein stated.

The Secretary of Commerce requested the Secretary of the Treasury (as had been done in preparation for the Thirteenth Census) to issue a circular letter to custodians of public buildings directing them, wherever practicable, to furnish suitable office accommodations to the census supervisors. The Secretary of the Treasury complied with this request, and it is expected that quarters in Federal buildings can be secured for a number of the supervisors.

The enumerators will be appointed by the supervisors, with the approval of the Director of the Census. Candidates will be required to fill out a sample census schedule from printed information pertaining to a number of hypothetical families stated in narative form, and in the case of enumerators whose work will be in rural districts, to fill out a sample schedule of agriculture, in order to demonstrate their fitness to perform the duties of an enumerator. No special educational qualifications will be necessary, but candidates for enumerators' positions should be active, energetic persons of good address and thorough trustworthiness and should be able to write legibly and with reasonable rapidity.

### OFFICE FORCE.

Although there will be a considerable increase in the amount of office work to be done in connection with the Fourteenth Decennial Census as compared with the Thirteenth, due to the growth of the population and industries of the country, it is estimated that the total force of official, clerical, and subclerical employees will reach at its maximum only about 4,000, as against 3,738 at the last census. The reason for this relatively small increase in force is found in the expectation of the Bureau that certain changes in organization, improvements in methods, and developments in tabulating machinery will make possible the accomplishment of a given amount of work with a somewhat smaller number of employees, on the average, than was required at the census of 1910.

The Fourteenth Census act fixes no limit upon the number of appointments which may be made to clerical and subclerical positions nor upon the number in any salary class, but provides that the number of temporary positions at salaries from $1,440 to $1,800 per annum, inclusive, shall at no time exceed 150. It further provides that the classification of the statutory force as fixed by the appropriation act for the fiscal year 1919, which included 65 clerks at $1,400, 30 at $1,600, and 20 at $1,800, shall be continued in effect during the decennial census period, thus making a maximum of 265 clerks, both permanent and temporary, who may be paid from $1,400 to $1,800 per annum, inclusive.

*Appointments.*—The minimum salary of $900 per annum for clerks authorized by the Fourteenth Census act represents an increase of 50 per cent over the entrance salary of $600 per annum paid the temporary clerks at the Thirteenth Census. Experience during that census clearly showed, however, that an entrance salary of only $600 was entirely too low to induce a sufficient number of capable persons to accept clerical employment in the Bureau. It will be necessary, therefore, if the large number of qualified employees needed are to be obtained, to offer an entrance salary which will enable appointees to meet the present abnormally high cost of living.

It is estimated that between 3,000 and 3,500 temporary clerks will be needed for this census. These clerks will be appointed, in most cases, as the result of special examinations to be conducted by the Civil Service Commission in the fall of this year throughout the United States, and the appointments will be apportioned as nearly as practicable among the several States and Territories and the District of Columbia on the basis of population. In order to meet the pressing needs of the Bureau in the meantime, however, a small number of the temporary clerical and subclerical positions, as well as vacancies on the permanent roll, are being filled by the following methods:

1. By selection from the reemployment registers of the Civil Service Commission established under authority of the Executive Order of November 29, 1918, as amended April 30, 1919. On these registers

are listed the names of all persons who were eligible for permanent employment in apportioned positions in the competitive classified service, who have been separated from competitive classified positions after less than three years' service, by reason of reductions in force, and who have been recommended for further employment by the Government because of efficient service.
2. By selection from the registers maintained by the Commission for the departmental service generally.
3. By transfer, reinstatement, or other method provided by the civil-service rules.

*Promotions.*—Although, as stated above, there is no limit placed upon the number of temporary clerks who may be appointed nor upon the number in any particular salary class, the law fixes the salary scale as follows: $900, $960, $1,000, $1,020, $1,080, $1,140, $1,200, $1,260, $1,320, $1,380, $1,400, $1,440, $1,560, $1,600, $1,680, and $1,800 per annum. This salary scale will enable the Bureau to adopt regulations that will provide for promotions at reasonably frequent intervals, with small increments, and for readjusting the compensation of the employees from time to time to make it commensurate with their general increase in efficiency as a result of experience gained in census work. It is anticipated that these small but relatively numerous increases will have a more beneficial effect on the morale of the force than larger increases at less frequent intervals would have.

## OFFICE AND FIELD EMPLOYEES AUGUST 31, 1919.

The following statement shows the nature and distribution of the office and field force on August 31, 1919:

### OFFICIALS.

| | |
|---|---|
| Director | Sam. L. Rogers. |
| Assistant director | William M. Steuart. |
| Chief clerk | Thomas J. Fitzgerald. |
| Chief statisticians: | |
| Population | William C. Hunt. |
| Agriculture, cotton and tobacco | William L. Austin. |
| Manufactures | Eugene F. Hartley. |
| Statistics of cities | Starke M. Grogan. |
| Vital statistics | William H. Davis. |
| Revision and results | Joseph A. Hill. |
| Disbursing clerk | Fred A. Gosnell. |
| Appointment clerk | Walter S. Gilchrist. |
| Geographer | Charles S. Sloane. |
| Expert chiefs of divisions: | |
| Administrative | Timothy F. Murphy. |
| Appointment | Emily I. Farnum. |
| Cotton and tobacco | Wesley E. Cilley. |
| Manufactures | John F. Daly. |
| Population | Edward B. White.<br>Edward W. Koch.<br>William B. Crago. |
| Revision and results | Harry H. Pierce. |
| Statistics of cities | Lemuel A. Carruthers. |
| Vital statistics | John B. Mitchell. |
| Chief, mechanical laboratory | E. M. LaBoiteaux. |

### CLERICAL FORCE.

| | |
|---|---|
| Statistical experts, $2,000 | 5 |
| Stenographers: | |
| $1,800 | 1 |
| $1,500 | 1 |
| Clerks: | |
| $1,800 | 24 |
| $1,680 | 10 |
| $1,600 | 15 |
| $1,560 | 42 |
| $1,440 | 17 |
| $1,400 | 58 |
| $1,380 | 10 |
| Clerks—Continued. | |
| $1,320 | 119 |
| $1,260 | 64 |
| $1,200 | 89 |
| $1,140 | 30 |
| $1,080 | 49 |
| $1,020 | 27 |
| $1,000 | 57 |
| $960 | 10 |
| $900 | 89 |
| Total | 717 |

### SUBCLERICAL FORCE.

| | | | |
|---|---|---|---|
| Photostat operators, $1,200 | 2 | Unskilled laborers, $720 | |
| Skilled laborers: | | Messengers, $840 | |
| $1,000 | 2 | Assistant messengers, $720 | |
| $900 | 3 | Messenger boys, $480 | |
| $840 | 2 | | |
| $720 | 1 | Total | |

### MECHANICAL LABORATORY.

| | | | |
|---|---|---|---|
| Experts: | | Mechanical draftsman, $1,600 | |
| $2,200 | 1 | Toolmakers: | |
| $2,000 | 2 | $1,600 | |
| $1,800 | 1 | $1,400 | |
| Mechanicians: | | Pressman and machinist, $1,400 | |
| $1,800 | 1 | General mechanic, $1,200 | |
| $1,600 | 1 | Machinist's helper, $1,000 | |
| Tabulating mechanicians: | | Shop apprentices: | |
| $1,600 | 3 | $840 | |
| $1,400 | 3 | $720 | |
| $1,200 | 1 | $600 | |
| Electricians: | | | |
| $1,600 | 1 | Total | |
| $1,400 | 2 | | |
| $1,200 | 1 | | |

### SPECIAL-AGENT FORCE.

Special agents for general field work, etc

### SUMMARY.

| | | | |
|---|---|---|---|
| Officials | 28 | Mechanical laboratory force | |
| Clerical force | 717 | Special agents | |
| Subclerical force | 39 | | |
| | | Total | |

In addition, there are employed throughout the cotton
local special agents to collect statistics of cotton and cott
These agents perform their work only at intervals and are
a piece-price basis.

### COOPERATION WITH OTHER FEDERAL SERVICES AND WITH O AGENCIES.

In making its plans for the present census the Bureau ha
as in the past, to eliminate duplication of work done by otl
ernment services and to make its published statistics as val
possible to the various organizations and interests, both
mental and nongovernmental, which have use for them.
ends it has sought, and has received in greater measure t
before, the full and hearty cooperation of other Federal
and offices and of outside agencies to whose activities th
statistics pertain.

In the course of the preparation of the agricultural s
many conferences were held with officials representing the
of Crop Estimates, the Bureau of Markets, the Office of Fa
agement, the Office of Farm Horticultural Investigations,
Division of Animal Husbandry in the Department of Ag
These conferences were characterized by a spirit of comp
mony, and all important decisions were reached by unanimo
ment. Subsequent conferences were attended not only b
sentatives of the Department of Agriculture but also by p
in agricultural colleges, editors of agricultural newspap
representatives of other agricultural interests.

In connection with the preparation of the irrigation schedule a conference was held with representatives of the Departments of Agriculture and of the Interior; and the Office of Public Roads and Rural Engineering in the Department of Agriculture, cooperated by making a test of the tentative schedule in several of the Western States.

The drainage schedule was drawn up after conference with representatives of the Departments of Agriculture and of War, representatives from several State universities, and a small number of the leading engineers of the United States.

In the formulation of many of the schedules to be used in the manufactures inquiry, consultations have been held with representatives of various Federal services, including the Bureau of Standards, Tariff Commission, Bureau of Chemistry, Bureau of Mines, Geological Survey, Bureau of Markets, and Bureau of Internal Revenue, and with representatives of the statistical organizations of the various States. The cooperation of chambers of commerce, leading manufacturers, and trade associations has also been sought. With the view of securing this cooperation and of enlisting the interest of the manufacturers and trade associations, the Director of the Census and the chief statistician for manufactures conferred with members of the National Industrial Conference Board, of Boston, and the National Association of Manufacturers, of New York, on June 9 and 12, respectively; and as a result of these conferences the general manager of the National Association of Manufacturers called a meeting of representatives of the various industrial organizations for the purpose of considering the tentative schedules of manufactures. By this means first-hand knowledge has been obtained as to the nature of the statistical information needed by the various industries. The responses of the industrial organizations have been gratifying as indicating their interest and desire to cooperate.

At a conference held in the office of the Director of the Census and attended by the Director of the United States Geological Survey, the Director of the Bureau of Mines, and other representatives of those services, it was agreed that the census of mines and quarries should be conducted in cooperation with the Geological Survey and the Bureau of Mines; and a committee composed of one representative each from the Bureau of the Census and the other offices named was appointed to consider all details as to the practical working out of the cooperative arrangement.

In preparation for the census of forestry and forest products, arrangements were made with the Forest Service of the Department of Agriculture whereby the lists of sawmills and other establishments consuming lumber and timber products, on file in that office, were placed at the service of the Census Bureau. A list of producers of naval stores was obtained from the Bureau of Chemistry, Department of Agriculture. Consultations were held with representatives of the Forest Service and correspondence was carried on with leading lumber manufacturers and associations in regard to the form of the schedule to be used in securing the data.

The census of Alaska is to be taken in cooperation with the Bureau of Education of the Department of the Interior. Mr.

William T. Lopp, in charge of the Alaskan division of the Bureau of Education, will supervise the work. (See subsection headed "Outlying possessions.")

The censuses of Guam, Samoa, and the Panama Canal Zone will be taken under plans agreed upon by representatives of the Bureau of the Census and of the War and Navy Departments. (See subsection headed "Outlying possessions.")

Arrangements have been made with the Treasury Department to provide offices in Federal buildings for supervisors of census wherever it is practicable to do so. (See subsection entitled "Field force.")

## PREPARATION OF SCHEDULES, INSTRUCTIONS, LISTS, ETC.[1]

A tentative general population schedule was prepared and printed in March, 1919. A few slight revisions were made, and a small number of copies were printed July 9, 1919, in final form. The full edition (2,500,000 copies) has been printed and is now being distributed to the supervisors and enumerators. This schedule is similar in general form to those used at the last two decennial censuses, the necessary changes in the inquiries being made to conform to the provisions of the Fourteenth Census act.

In connection with the preparation of the agricultural schedules, the officials of the division of agriculture held numerous conferences with persons designated to represent the various governmental departments which are interested in agricultural statistics, as well as with professors in agricultural colleges and representatives of agricultural periodicals and of farmers' associations. As a result of these conferences, a general farm schedule was formulated which has been very widely indorsed and has received the unqualified approval of the Joint Advisory Committee of the American Statistical and Economic Associations. This schedule, the schedule for live stock not on farms and ranges, the schedule for drainage, and the schedule for irrigation have all been printed.

Summaries of the reports of the census supervisors for 1910 as to the methods pursued in the conduct of the field work have been made as a guide to the work of the Fourteenth Census. These summaries cover the methods employed in the division of each district into enumeration districts; the selection and instruction of enumerators and the supervision of their work; the use of advance schedules for population and agriculture; rates of pay of enumerators; and methods employed by newspapers, private organizations, etc.

The general instructions to supervisors have been printed, and the instructions to enumerators, as well as other forms, are in process of preparation.

The compilation of the occupation index to be used at the Fourteenth Census has been nearly completed. More than 100,000 slips have been prepared covering occupational designations not contained in the index used at the Thirteenth Census, and these slips have been arranged according to occupation symbols and are being considered in reference to their numerical importance with the view of their use in the new index for the Fourteenth Census. This index, alphabetically arranged, to be used by the classifying clerks, will comprehend practically 20,000 occupational designations and will fill 400 printed pages.

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[1] See also preceding subsection.

A card index giving names, addresses, and character of products for establishments to be covered by the censuses of manufactures, mines and quarries, and forestry and forest products has been prepared from schedules of the 1914 census of manufactures, business trade directories, and lists on file in other bureaus and offices of the Government.

The preparation of a complete list of factories for which reports will be made from central offices is now in progress. This list will be perfected by correspondence with each company that made a report of this character at the last census, as well as with others that will be listed in the new card index as having come into existence at later dates.

The Bureau has prepared a list of the forms to be used in the enumeration, showing size of edition, dates when copy will be supplied, and when deliveries must be made.

## ENCUMBRANCES ON HOMES.

Section 8 of the Fourteenth Census act contains a provision, inserted in the Senate, for ascertaining the amount of encumbrance on mortgaged homes. This refers only to mortgaged homes occupied by their owners, of which in 1920 there may be approximately 4,000,000. This number includes 1,500,000 mortgaged farm homes, for which provision for securing this information has been made on the regular farm schedule, and 2,500,000 mortgaged homes in city districts, for which the necessary information can not be secured on the general population schedule and for which, therefore, a special schedule will be required.

The number of owned encumbered homes will be determined through inquiries on the general population schedule by the enumerators in January, 1920, but the information as to the amount of encumbrance will be later secured from the owners of the encumbered homes by the use of a special schedule, this supplemental inquiry to be conducted partly by correspondence and partly by the use of special agents.

The Fourteenth Census act as originally drawn did not provide for an inquiry as to encumbrances on homes occupied by owners, for which reason the estimate of the total cost of the Fourteenth Census work did not cover the cost of this inquiry. In order, therefore, to comply properly with this special provision of the census act, an appropriation of at least $1,000,000 will be required to cover the additional cost of collecting and compiling this information.

An investigation regarding the encumbrance on homes was first made at the census of 1890, for which an appropriation of $1,000,000 was made in addition to the regular census appropriations.

### OUTLYING POSSESSIONS.

The Fourteenth Census act provides for censuses of Alaska, Hawaii, and Porto Rico, to be taken by the Bureau of the Census, and also for censuses of Guam, Samoa, and the Panama Canal Zone, to be taken by the respective governors of those possessions in accordance with plans prescribed or approved by the Director of the Census.

*Alaska.*—In taking the census of Alaska the Bureau of the Census will cooperate with the Bureau of Education. The plan of cooperation, which received the approval of the Secretary of Commerce June 3, 1919, and of the Secretary of the Interior on June 14, 1919, provides for the employment (1) of Mr. William T. Lopp, in charge of the Alaskan Division of the Bureau of Education, with headquarters at Seattle, Wash., as chief special agent in charge of the Alaskan census; (2) of the six district superintendents of schools in Alaska as special agents in charge of the enumeration work in their respective school districts; (3) of local teachers as enumerators wherever practicable; and (4) of the Bureau of Education bookkeeper in Seattle as special disbursing agent for the census and of his clerk as special agent for clerical service in connection with the census. The schedules, blanks, and other supplies were shipped to Mr. Lopp at Seattle on July 17, ready for transportation to his census headquarters at Juneau.

*Hawaii and Porto Rico.*—Supervisors have been appointed for Hawaii and Porto Rico, and the schedules and blanks, which will be substantially the same as those used for continental United States, are being printed.

*Other outlying possessions.*—Plans for the censuses of Guam, Samoa, and the Panama Canal Zone have been perfected in conference with officials of the War and Navy Departments. The census in each instance will be taken under the immediate direction of the governor, who will be supplied with schedules and other blank forms from this Bureau. The schedules will be less elaborate than those used in continental United States.

Arrangements have also been made, through the Chief of the Bureau of Insular Affairs, War Department, for securing the detailed results of the census of the Philippine Islands, taken by the Philippine Government as of December 31, 1918, as fast as they are available, for incorporation in the announcements and reports of the Fourteenth Census of the United States.

### MILITARY AND NAVAL POPULATION.

Steps are being taken toward providing, through the War and Navy Departments, for the proper enumeration of all persons in the military and naval services, and of all civilians engaged in or identified with war work, who are likely to be absent from their usual places of residence at the time the census is taken in January, 1920.

### MISCELLANEOUS PREPARATORY WORK.

An irrigation expert and a drainage expert have been appointed to take charge of the irrigation and drainage inquiries, under the direct supervision of the chief statistician for agriculture, and the necessary preparatory work for these inquiries is under way.

The Bureau is now in correspondence with chambers of commerce and other industrial organizations with the view of extending the territory to be comprised in the "metropolitan districts," or industrial zones, and increasing the number of such districts.

Consideration has been given to the requirements of the card-punching work, including the preparation of a punch card, and arrangements are being made with the Government Printing Office for securing an adequate supply of satisfactory paper for punch cards.

Certain experimental tabulations and studies have been made with the view of a better presentation of the statistics in reports and bulletins.

A brief report on the methods of taking censuses in foreign countries has been prepared.

### MECHANICAL EQUIPMENT.

*Work in mechanical laboratory.*—The object of the mechanical laboratory, to have produced or to have on hand at the close of the fiscal year 1919 all parts entering into the construction of certain tabulating machinery for the work of the Fourteenth Census, comprising 40 automatic tabulator heads, 35 bases with full complements of counters, and 25 sorting machines, has been practically attained.

It was considered advisable to build larger numbers of machines and accessories than were called for in the original estimates. The numbers of the several machines and parts finally determined upon, the numbers originally estimated, and the percentages of increase are as follows:

| Item. | Number determined upon. | Number originally estimated. | Per cent of increase. |
|---|---|---|---|
| Automatic tabulator heads | 40 | 25 | 60.0 |
| Automatic tabulator bases | 35 | 30 | 16.7 |
| Sorting machines | 25 | 19 | 31.6 |
| Counter units | 156 | 114 | 36.8 |

Each tabulating machine will be equipped with from one to six counter units, each of which will have sufficient capacity to record 10 numbers of four figures each.

More work of an assembling nature was carried on during the latter part of the fiscal year than was thought possible in the beginning. For the permanent use of the division of vital statistics 4 tabulators and 3 sorting machines have been completed and installed and 77 pantograph punching machines have been overhauled and equipped with composite key plates in conformity with the latest forms of the mortality and birth cards. In all, five tabulators have been completed and tested, of which the four just referred to are in actual use. The remainder of the equipment of tabulating and sorting machines intended for population work will be completed on or before February 1, 1920, in ample time to have them in readiness for the Fourteenth Census work.

Of the total numbers of machines determined upon, there had been completed and tested up to September 15, 1919:

| | |
|---|---|
| Tabulating machines | 14.2 per cent. |
| Sorting machines | 12.0 per cent. |

The estimated percentages of work accomplished on the remaining machines to September 15, 1919, were:

| | |
|---|---|
| Automatic tabulator heads | 95 per cent. |
| Automatic tabulator bases | 87 per cent. |
| Sorting machines | 82 per cent. |

The original estimates pertaining to the sorting machines took into consideration merely the work of overhauling. It was later found expedient to introduce some radical changes in design and method of operation, and the result has been the production of a practically new and much more efficient machine.

Supplies and maintenance, as needed, have been furnished the Bureau of Immigration for its tabulating machinery.

*Integrating counter.*—In my last two reports I have referred to the progress of the development of an "integrating counter"—that is, a counter which will record and add numbers instead of mere units, thus performing automatically the work done by the operator of an adding machine—for use in tabulating certain classes of census data, such as those pertaining to agriculture and manufactures. The numbers will be indicated on cards by punch marks, the cards will be fed into the machine, and the numbers will be automatically totalized. Several sets of figures can be totalized at the same time. The principal advantage to be derived from the use of the integrating counter lies in the facility with which the data, as indicated on the cards by the punch marks, may be regrouped or rearranged so as to obtain totals for the various classifications desired.

Work on the integrating counter, which began on July 6, 1917, was continued during the fiscal years 1918 and 1919, and is still in progress. The first model has been completed as an experimental machine, and it has automatically added and recorded numbers as indicated on punched cards at the rate of 20,000 to 25,000 cards a day. The machine is small and compact and does not depend upon electricity for its operation, except that it is motor driven. It may be operated wherever a connection can be made to an electric-lamp socket or outlet carrying a 110-volt direct current. A complete set of drawings and all patterns necessary for manufacturing this type of machine have been made.

A tentative card system for tabulating part of the manufactures census has been developed and will be given a test.

### OFFICE ROOM AND STORAGE SPACE.

The Bureau of the Census will employ during the Fourteenth Census period (July 1, 1919, to June 30, 1922), a greatly increased clerical force in Washington, numbering at its maximum about 4,000. Moreover, it will need floor space for the many machines that will be used in tabulating the results of the census and storage space for the millions of schedules containing the data gathered by the field force and the 300,000,000 or more cards which will be used in tabulating the population and agricultural statistics. It thus became necessary to seek additional quarters. Accordingly, arrangements were made with the War Department and Public Buildings Commission for the use of Building D (one of the temporary buildings erected during the period of the war), at Four-and-a-half Street and Missouri Avenue NW., by the Census Bureau during the Fourteenth Census period. This is a three-story frame structure with eight wings and a head house on each floor, and, exclusive of corridors, aisles, toilets, etc., contains 237,000 square feet of floor space.

A number of alterations and repairs and some new construction are necessary in order to render this building suitable for the use of the Bureau. These changes consist mainly in shoring up the floors of four wings, the construction of bridges between certain wings, the installation of three freight elevators, and the construction of a fireproof vault in which to keep the population schedules of the Fourteenth Census. It had been the desire of the Bureau to begin this work early in the spring of 1919, and accordingly an item was incorporated in the third deficiency bill, reported in the House of Representatives on February 27, 1919, to make immediately available $200,000 of the Fourteenth Census appropriation to cover the cost of the alterations, etc., in question; but the bill failed to pass, and as a result the Bureau was delayed in beginning the work. It is now under way, however, and will be pushed to completion as rapidly as possible.

On July 1 one-half of building D was made available for the use of the Census Bureau, the other half being retained by the Air Service; and on July 1 and 2 the divisions of population and agriculture, and on August 12 the geographer's division, were removed to that building. As the work of the division of manufactures, which is housed in the Commerce Building, expands, it will be necessary to transfer other divisions to Building D. This will require the use of the entire building, which is to be turned over to the Bureau by January 1, 1920.

This arrangement is the best that could be made under the existing circumstances, but I regard it as very unfortunate that the important records of a decennial census must be constantly exposed to destruction by fire in a temporary frame structure. I sincerely hope that by the time the next census is taken the Government will have adopted a building policy which will permit the housing of the census force in a modern, fireproof building. Furthermore, the separation of the force is not conducive to good administration. Although the main work of the decennial census is not yet under way, much inconvenience and lost motion have already resulted from the lack of direct contact with each unit of the organization.

## PUBLICATIONS ISSUED.

Following is a list of the publications issued during the fiscal year and since its close. In addition, the Bureau has published a number of press summaries.

| Class and title. | Date issued. | Pages. | Edition. |
|---|---|---|---|
| JULY 1, 1918, TO JUNE 30, 1919. | | | |
| Reports (cloth bound and of quarto size, except as otherwise indicated): | | | |
| Birth statistics for the registration area of the United States: 1916 | Nov. 6, 1918 | 96 | 5,000 |
| Financial statistics of cities having a population of over 30,000: 1917 | Oct. 5, 1918 | 373 | 6,500 |
| Financial statistics of States: 1917 (cloth and paper) | Oct. 10, 1918 | 129 | 3,500 |
| Statistics of fire departments of cities having a population of over 30,000: 1917 (paper) | Aug. 13, 1918 | 105 | 6,000 |
| Specified sources of municipal revenues: 1917 | Aug. 28, 1918 | 140 | 6,000 |
| Deaf mutes in the United States: 1910 | July 5, 1918 | 221 | 2,000 |
| Census of manufactures, 1914—Vol. I, reports by States and principal cities [a] | Feb. 26, 1919 | 1,677 | 1,500 |
| Mortality statistics: 1916 | Sept. 27, 1918 | 543 | 5,000 |
| Marriage and divorce: 1916 (paper) | Apr. 4, 1919 | 47 | 5,000 |
| Negro population in the United States: 1790–1915 | Oct. 28, 1918 | 844 | 5,000 |
| Prisoners and juvenile delinquents | Oct. 28, 1918 | 535 | 4,000 |
| Census of the Virgin Islands of the United States: Nov. 1, 1917 | Aug. 27, 1918 | 147 | 4,000 |
| Total | | 4,857 | 53,500 |
| Bulletins (quarto): | | | |
| No. 136—Stocks of leaf tobacco (octavo) | July 17, 1918 | 44 | 20,000 |
| No. 137—Cotton production and distribution, season of 1917–18 | Jan. 1, 1919 | 135 | 37,500 |
| No. 138—Estimates of population in the United States: 1910–17 | Jan. 21, 1919 | 57 | 3,000 |
| Textiles—census of manufactures: 1914 | Sept. 30, 1918 | 165 | 500 |
| Shipbuilding (including boat building): 1916 and 1914 [b] | May 16, 1919 | 35 | 2,500 |
| Total | | 436 | 63,500 |
| Miscellaneous publications: | | | |
| Annual report of the Director of the Census to the Secretary of Commerce, fiscal year 1918 (octavo) | Oct. 21, 1918 | 28 | 2,500 |
| Census publications available for distribution by the Bureau of the Census, Apr. 1, 1919 (octavo) | Apr. 26, 1919 | 16 | 500 |
| Manual of the international list of causes of death (third reprint revised) (octavo) | July 13, 1918 | 309 | 500 |
| Advance tables of cotton production in the United States—crop of 1917 (octavo) | July 27, 1918 | 40 | 42,000 |
| Advance tables of cotton production in the United States—crop of 1918 (octavo) | June 23, 1919 | 40 | 36,000 |
| Act providing for the Fourteenth Census, to be taken Jan. 1, 1920 | Apr. 17, 1919 | 23 | 1,000 |
| Supervisors' districts, 1920—Fourteenth Census | May 3, 1919 | 75 | 1,500 |
| Thirty-four reports, in card form, relating to cotton and cotton seed | June 14, 1918 to June 19, 1919 | 34 | 1,360,000 |
| Four reports, in card form, relating to stocks of leaf tobacco | July 29, 1918 to Apr. 30, 1919 | 4 | 77,000 |
| Total | | 569 | 1,521,000 |
| Special censuses (octavo): | | | |
| Population of Okmulgee County, Okla. (enumerated Aug. 15, 1918) | Jan. 6, 1919 | 16 | 500 |
| Population of Ottawa County, Okla. (enumerated Dec. 16, 1918) | Feb. 26, 1919 | 15 | 500 |
| Population of Tulsa County, Okla. (enumerated Jan. 15, 1919) | Apr. 24, 1919 | 19 | 800 |
| Total | | 50 | 1,800 |
| Census of war commodities (quarto): | | | |
| Antimony, and graphite crucibles | Apr. 4, 1919 | 10 | 500 |
| Iron and steel | Jan. 31, 1919 | 16 | 1,500 |
| Statistics of leather | Dec. 12, 1918 | 11 | 1,000 |
| Textile fibers—wool, silk, jute, and kapok | Apr. 17, 1919 | 16 | 1,500 |
| Total | | 53 | 4,500 |
| Grand total, July 1, 1918, to June 30, 1919 | | 5,965 | 1,644,300 |
| JULY 1 TO AUG. 31, 1919. | | | |
| Reports (cloth bound and of quarto size, except as otherwise indicated): | | | |
| Census of manufactures, 1914-Vol. II, reports for selected industries and detailed statistics for industries by states [a] | July 2, 1919 | 1,047 | 1,500 |
| Telegraphs and municipal electric fire-alarm and police-patrol signaling systems: 1917 (paper) | July 19, 1919 | 61 | 3,000 |
| Municipal markets in cities of over 30,000: 1918 (paper) | July 23, 1919 | 19 | 1,500 |
| Total | | 1,127 | 6,000 |
| Census of war commodities (quarto): Leather statistics—Boots, shoes, and manufactured leather | Aug. 25, 1919 | 19 | 1,500 |
| Grand total, July 1 to Aug. 31, 1919 | | 1,146 | 7,500 |

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[a] The various reports bound together in these volumes had previously been published separately.
[b] Withheld from earlier publication for military reasons.

## APPROPRIATIONS AND EXPENDITURES.

### FINANCIAL STATEMENT, FISCAL YEAR 1919.

| Division. | Salaries. | Subsistence and travel. | Other. | Total. |
|---|---|---|---|---|
| Administrative: | | | | |
| Salaries | $64,351.57 | $322.25 | $2.45 | $64,676.27 |
| Contingent expenses | | | [a] 23,261.14 | [a] 23,261.14 |
| Mechanical laboratory | 32,638.86 | | 10,629.59 | 43,268.45 |
| Revision and results | 23,451.30 | | | 23,451.30 |
| Population | 115,694.90 | 857.73 | 1,745.66 | 118,298.29 |
| Manufactures | 244,519.13 | 29,492.55 | 195.14 | 274,206.82 |
| Geographer's | 42,879.87 | | 6.58 | 42,886.45 |
| Vital statistics | 160,399.99 | 4,273.29 | 73,631.90 | 238,305.18 |
| Statistics of States and cities | 79,708.69 | 28,456.34 | 109.16 | 108,274.19 |
| Agriculture | 30,319.50 | 57.00 | 103.33 | 30,479.83 |
| Cotton and tobacco | 40,461.05 | 136.92 | 230,277.20 | 270,875.17 |
| Salaries of employees detailed to Department of Commerce | 998.98 | | | 998.98 |
| Printing and binding | | | [a] 113,971.18 | [a] 113,971.18 |
| War work: | | | | |
| Registration | 1,047.07 | | | 1,047.07 |
| Liberty loans | 2,775.86 | | | 2,775.86 |
| Census of jute | 1,632.92 | | | 1,632.92 |
| Census of antimony | 1,303.50 | | | 1,303.50 |
| Census of leather stocks | 35,858.72 | | | 35,858.72 |
| Census of silk | 987.14 | | | 987.14 |
| Census of boots, shoes, and leather goods | 52,484.77 | 120.61 | | 52,605.38 |
| Census of graphite crucibles | 1,679.28 | | | 1,679.28 |
| Census of woolen manufactures | 3,001.01 | | | 3,001.01 |
| Census of iron and steel | 11,526.01 | | | 11,526.01 |
| Data for foreign countries | 4,069.87 | | | 4,069.87 |
| Commercial greenhouses | 7,407.17 | 48.00 | 3.85 | 7,459.02 |
| Grain-trade investigation | 32,472.66 | | | 32,472.66 |
| Confidential work for Navy Department | 1,112.50 | | | 1,112.50 |
| Ages of registrants | 2,139.99 | | | 2,139.99 |
| Miscellaneous | 27,669.96 | 107.05 | 18,443.95 | 46,220.96 |
| Purchase and repair of punching machines | | | 35,000.00 | 35,000.00 |
| Total for Bureau | 1,022,592.27 | 63,871.74 | 507,381.13 | 1,593,845.14 |

| Title of appropriation. | Appropriation. | Expenditures during fiscal year. |
|---|---|---|
| Salaries, Bureau of the Census, 1919 | $739,240.00 | $682,161.95 |
| Collecting statistics, Bureau of the Census, 1919 | 490,000.00 | 466,091.95 |
| Tabulating machines, Bureau of the Census, 1919 | 60,000.00 | 40,993.44 |
| Punching machines, Bureau of the Census, 1919 | 60,000.00 | 35,000.00 |
| National Security and Defense, Department of Commerce (special statistical work), 1919 | 150,000.00 | 138,329.50 |
| National Security and Defense, Department of Commerce (uniform nomenclature), 1919 | 10,000.00 | 9,895.56 |
| Contingent expenses, Department of Commerce, 1919 [a] | 23,261.14 | 23,261.14 |
| Printing and binding, 1919 [a] | 113,971.18 | 113,971.18 |
| Increase of compensation, Department of Commerce, 1919 | 84,140.42 | 84,140.42 |
| | 1,730,612.74 | 1,593,845.14 |

[a] Paid from appropriation for Department of Commerce; no separate appropriation for the Bureau of the Census.

### APPROPRIATION, FISCAL YEAR 1920.

The Census Bureau's appropriation for the fiscal year 1920 was made in a single lump sum of $15,000,000. The Bureau's estimate of the cost of taking the Fourteenth Decennial Census was $18,129,000, and the cost of the annual and other nondecennial work to be done during the three-year census period (July 1, 1919, to June 30, 1922) was estimated at $2,371,000, making a total of $20,500,000. It was impossible to apportion, with any approach to accuracy, the cost of the work among the three fiscal years which will constitute the census period. Obviously, however, the greater part of the total expense of the census will fall within the first fiscal year, during which the bulk of the payments for field work will be made.

## ESTIMATED EXPENDITURES DURING FOURTEENTH CENSUS PERIOD.

After the estimate was prepared, provision for an additional inquiry, relating to encumbrances on homes, was inserted in the census bill by the Senate. The inclusion of this inquiry in the Fourteenth Census work (as explained in the section entitled "Preparations for the Fourteenth Census") will add approximately $1,000,000 to its cost. An additional estimate of $50,000 has been made necessary on account of the construction of a fireproof vault, the installation of elevators, the strengthening of floors, etc., at Building D, one of the temporary war buildings, at Four-and-a-half Street and Missouri Avenue NW., which has been assigned to this Bureau for the use of the Fourteenth Census force. On the other hand, the original estimate of $300,000 for rent of buildings in the District of Columbia has been eliminated, in view of the assignment of the temporary war building to this Bureau. An item of $35,000 for fuel has also been eliminated, as the cost of heating Building D will be paid by the office of the Superintendent of the State, War, and Navy Building. These changes are equivalent to a net increase of $715,000, making the revised estimate of the cost of the Fourteenth Decennial Census inquiries amount to $18,844,000. This represents an increase of 29 per cent over the corresponding amount expended to cover the cost of the Thirteenth (1910) Census inquiries, which exceeded by 23 per cent the cost of the Twelfth (1900) Census work. It should be borne in mind, however, that neither the Thirteenth nor the Twelfth Census contained the inquiry on encumbrances on homes, for which an estimate of $1,000,000 is made for the Fourteenth Census.

The estimate for the Fourteenth Census, which was a very conservative one, was made in the expectation that prices and wages would have made some progress toward a return to a normal level before it became necessary to purchase supplies and engage enumerators and other field employees, but thus far that expectation has not been realized. With the prevailing wage scales and the high prices of equipment, supplies, etc., it is possible that the Bureau's estimate may prove to be too low.

The following statement shows in detail the estimated expenditures during the Fourteenth Census period:

### DECENNIAL CENSUS INQUIRIES.

| | |
|---|---|
| POPULATION: | |
| Field work (including outlying possessions)— | |
| Supervisors (salaries, expenses, and assistance) | $750,000 |
| Enumerators | 3,600,000 |
| Interpreters | 50,000 |
| Miscellaneous (reenumerations, etc.) | 100,000 |
| Collecting data on encumbered homes | 500,000 |
| Total, field work | 5,000,000 |
| Office work, total salaries | 2,900,000 |
| Mechanical laboratory (salaries, supplies, etc.) | [a] 100,000 |
| Total, Population | 8,000,000 |
| AGRICULTURE: | |
| Field work (including outlying possessions)— | |
| Supervisors (salaries, expenses, and assistance) | 750,000 |
| Enumerators | 3,541,000 |
| Irrigation (compensation, subsistence, travel, etc—field employees) | 106,000 |
| Drainage (compensation, subsistence, travel, etc.—field employees) | 170,000 |
| Special field work | 42,000 |
| Total, field work | 4,609,000 |
| Office work, total salaries | 1,440,000 |
| Total, Agriculture | 6,049,000 |

[a] Exclusive of work on integrating counter.

| | |
|---|---|
| MANUFACTURES AND MINES AND QUARRIES: | |
| Field work, including outlying possessions (compensation, subsistence, travel, etc., of field employees) | $1,056,000 |
| Office work, total salaries | 1,192,000 |
| Total, Manufactures and Mines and Quarries | 2,248,000 |
| FORESTRY AND FOREST PRODUCTS: | |
| Field work, including outlying possessions (compensation, subsistence, travel, etc., of field employees) | 4,000 |
| Office work, total salaries | 23,000 |
| Total, Forestry and Forest Products | 27,000 |
| ADMINISTRATIVE AND GENERAL: | |
| Salaries for Director's Office, Administrative Division, Appointment Division, Disbursing Office, Geographer's Division, Publication Division, and Editorial Division | 975,000 |
| Printing (including cards for tabulating machines and other job work) | 821,000 |
| Stationery, supplies, and equipment (other than for mechanical laboratory), office maintenance, etc | 724,000 |
| Total, Administrative and General | 2,520,000 |
| Grand total, decennial census inquiries | 18,844,000 |
| Grand total decennial census inquiries, Thirteenth Census (1910), including work done after close of census period | $14,570,946 |
| Grand total Twelfth Census (1900) | $11,854,818 |
| Per cent of increase, 1910–1920 | 29 |
| Per cent of increase, 1900–1910 | 23 |

OTHER WORK DURING DECENNIAL CENSUS PERIOD.

| | |
|---|---|
| OFFICIAL REGISTER FOR 1919 AND 1921: | |
| Office work, total salaries | $12,000 |
| VITAL STATISTICS (annual): | |
| Field work (transcripts of records and subsistence and travel) | 340,000 |
| Office work, total salaries | 410,000 |
| Total, Vital Statistics | 750,000 |
| STATISTICS OF STATES AND CITIES (annual): | |
| Field work (compensation, travel, subsistence, etc., of field employees) | 210,000 |
| Office work, total salaries | 150,000 |
| Total, Statistics of States and Cities | 360,000 |
| COTTON AND COTTONSEED STATISTICS (monthly and semimonthly): | |
| Field work (pay of local agents on piece-price basis) | 825,000 |
| Office work, total salaries | 90,000 |
| Total, Cotton and Cottonseed Statistics | 915,000 |
| TOBACCO STATISTICS (quarterly): | |
| Field work (compensation, subsistence, travel, etc., of field employees) | 45,000 |
| Office work, total salaries | 30,000 |
| Total, Tobacco Statistics | 75,000 |
| GENERAL: | |
| Printing | 182,000 |
| Stationery, supplies, and equipment | 12,000 |
| Total, General | 194,000 |
| INTEGRATING COUNTER: | |
| Work of development, construction, and maintenance (salaries, supplies, etc.) | 65,000 |
| Grand total, other work during decennial census period | $2,371,000 |
| Aggregate, all work done during decennial census period | $21,215,000 |

Respectfully,

SAM. L. ROGERS,
*Director of the Census.*

To Hon. WILLIAM C. REDFIELD,
*Secretary of Commerce.*

# REPORT

## OF THE

# COMMISSIONER OF FISHERIES

# REPORT

## OF THE

# COMMISSIONER OF FISHERIES.

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DEPARTMENT OF COMMERCE,
BUREAU OF FISHERIES,
*Washington, October 10, 1919.*

SIR: In presenting this report in which is given a résumé of the varied activities of the Bureau of Fisheries for the fiscal year ending June 30, 1919, I take the liberty to express appreciation of your sustained interest in and ever-ready, helpful criticism of the Bureau's work and to acknowledge your potent assistance which has made it possible for the Bureau to assume larger functions of public usefulness than it ever had before and has prepared the way for still greater service and achievement. To state that you have made permanent impress on this Bureau's career is but to repeat what is generally held by the responsible employees in office and field.

This occasion is taken to reaffirm the critical condition that has been created by the long continuance of inadequate compensation in all grades of the service. The prospective recommendations of the Joint Congressional Commission on the Reclassification of Salaries are confidently expected to meet and counteract the disorganizing situation now confronting the office force in Washington; but the labors of the commission will be futile, so far as this Bureau is concerned, if provision is not speedily made by Congress for the rectification of salaries in the field.

## RELATIONS WITH THE FISHERY INDUSTRIES.

### SUMMARY OF ACTIVITIES.

Inasmuch as outside of Alaska the Bureau exercises no jurisdiction over the fisheries, its relations therewith are necessarily confined to advisory, investigational, educational, and informative work to meet the special requirements of the country at large, the individual States, and various branches of the fishery industries.

The need for food production and food conservation during the war and post-war periods has afforded unprecedented opportunities for increasing the consumption of fish and incidentally for developing uses for by-products of the fisheries. Appreciative of these opportunities, and being desirous of contributing its full share of effort during the great national emergency, the Bureau has made use of all available means to secure the fullest practicable utilization of the country's aquatic resources. To this end it has cooperated effectively with Federal and State food administration representatives and other governmental agencies, with producers, with the trade, with civic organizations, and with other elements of the population. By lectures and practical demonstrations it has shown directly to some fifteen thousand housewives the value of fish as food and the best and most economical methods of preparing it for the table, and in this way it has been enabled to show the merits of many of the little-used or neglected fishes which are fully the equal of more valued species, thereby increasing the fisheries and the markets for such forms at a time when they were needed most. It has augmented materially the saving and use of waste products of the fisheries, as, for example, the conversion of fish waste and waste fish into oil and fish scrap for fertilizer or fish meal as an animal feed, and the making of leather from the skins of aquatic animals. New or foreign methods of preservation have been introduced and wasteful practices have been discouraged. Investigations of the basic principles governing the methods of preservation of fishery products, for which there is a long-felt want, have been initiated and are yielding important results. A fishery-products laboratory in which such investigations can be continued under accurately controlled conditions has been built and equipped, and a temporary experimental field laboratory has been placed in operation.

The Bureau has also given greater attention to the collection of fishery statistics, which afford the only available, reliable basis for determining the condition and trend of the commercial fisheries of the country, serve as a guide for the enactment of necessary protective legislation, and indicate the need for and results of fish-cultural operations. The monthly returns of the quantities and values of the fish landed at Boston and Gloucester, Mass.; Portland, Me.; and Seattle, Wash., by American and Canadian vessels have been submitted by local agents and published as monthly and annual bulletins for the use of the trade. A statistical canvass of the fisheries of the Great Lakes, together with Lake of the Woods, Rainy Lake, and Lakes Kabetogama and La Croix, was made during the year, and a special bulletin on the subject was issued. In addition, there have been initiated and are nearing completion a comprehensive canvass of the fisheries of the South Atlantic and Gulf States for the calendar year 1918, and canvasses of the shad and river-herring fisheries of the Potomac River and of the shad fishery of the Hudson River for the calendar year 1919.

Plans are being developed for taking statistical canvasses with sufficient frequency to include all of the major geographical divisions of the fisheries once in a five-year period. To complete this work satisfactorily and take up such special canvasses as are required from time to time will require a somewhat larger force of statistical agents and clerks.

## INCREASING PRODUCTION AND CONSUMPTION OF FISHERY PRODUCTS.

The Bureau has encouraged west-coast whaling companies to save and market whale meat for food and has rendered effective assistance in bringing the merits of whale meat to the attention of consumers. In 1918, 30,000 cases of the meat were canned and 195 tons were frozen for market, the latter being utterly inadequate to supply the demand. Equipment has now been provided for an output of 50,000 cases of canned meat and 1,000 tons of frozen meat in 1919. Samples of the canned meat examined by the Bureau were found to be of good quality and to constitute a cheap and wholesome food. It is reported that in 1918 the principal whaling company on the Pacific coast, with stations in Washington, British Columbia, and Alaska, took 999 whales, of which about 200 were of the sei species (*Balænoptera borealis*) whose meat is light-colored and particularly good for canning. Attention has been given to the renewal off the coast of Maine of a fishery for whales, the flesh of which is to be marketed for food, and various persons connected with the fisheries are considering the practicability of such an undertaking. Interest has been aroused in Texas in the use of the meat of porpoises, which are reported to occur in numbers on the coast of that State. It has been ascertained that the oily taste which may be more or less objectionable to some persons can be overcome by removing the connective tissue which lies between the blubber and the meat. Some difficulty was experienced in inducing fishermen to provide the markets with supplies sufficient to satisfy the demand. An economic circular containing 32 recipes for preparing the meat of whales and porpoises for the table has been issued.

Being convinced that the production of fish in the States bordering on the Gulf of Mexico could be materially increased if larger markets to care for the surplus catch were provided, the Bureau cooperated with representatives of the Department of Agriculture and the Food Administration in securing the introduction of Gulf fish into Nashville, Louisville, Indianapolis, and neighboring points, and introduced approximately half a million pounds of fish from points in Florida into these cities. To effect relief for unsatisfactory shipping conditions, similar service was inaugurated between Chincoteague, Va., and the markets of Philadelphia and New York, and a number of shipments were made under supervision of Government agents.

Nearly 14,000 cases of canned river-herring products (fish, roe, and buckroe), sea herring and gadoid buckroe, valued at over $54,000, were introduced to the markets of Atlanta, Birmingham, Montgomery, Knoxville, Nashville, and Chattanooga, largely as a result of exploitation work conducted by agents of the Bureau.

On the fishing banks in the Gulf of Mexico groupers are more abundant than snappers. The demand for snappers has been in excess of the supply, while that for grouper has normally been insufficient to care for more than half of the catch, with the result that quantities of these wholesome, white-meated fishes have been wasted, and valuable time has been lost by the fishermen in searching for the highly prized snappers. During the war, owing to the reduction in the size of the fleet, most of the groupers taken could be marketed. Recently, with an increase in the number of vessels operating, the catch has again exceeded the demand. The Bureau has, therefore, carried on extensive exploitation measures in inland cities of the South in an effort to stimulate sufficient demand to care for the entire catch. Restaurants and cafés, in particular, have been encouraged to use these fishes. A placard recommending groupers and an economic circular containing 29 recipes for preparing them for the table have been issued for the use of the trade.

The lack of a market for the catch of black drum, the destructiveness of this fish to oysters, and the excellent quality of the canned product have led the Bureau to undertake a special movement to popularize the fish, and an assistant was detailed to visit fishing centers on the Gulf coast for detailed information regarding abundance, seasons, etc. Of points on the Florida coast, Cedar Keys appears best suited for the establishment of a fishery, the fish being reported as plentiful throughout the year. An even larger supply appears to be available at Point Isabel, Tex., where about 70 per cent of all fish taken is reported to be black drum. At this place the fish are caught throughout the year with pocket nets; that is, drag seines provided with pockets. The information gathered will be brought to the attention of those interested in establishing a fishery or a cannery for this fish.

Efforts have been put forth to stimulate the production and consumption of many other products, including alewives or river herrings, carp, crevalles, eulachon, red drum, robalo, rockfishes, sea catfish, rays, sharks (fresh, salted, and smoked), the roe and buckroe of fishes, sea mussels (canned), squid, etc.

## DEMONSTRATIONS IN FISH COOKERY.

No recent activity of the Bureau in the field of practical fishery work has met with such universal favor among producers, dealers, and consumers as its lectures and demonstrations in the methods of preparing and cooking fish.

Demonstrations were first given in Seattle, Wash., in May, 1918, with the object of showing housewives the best and most economical methods of preparing and cooking fish and of acquainting them with the merits of many of the common fish and fishery products with which they had little or no acquaintance. This work was extended to 15 other cities and towns in the States of Washington, Oregon, and California, and was highly commended in every center. In February, 1919, when the supplies of fish in the cold storages of the country were about double the normal holdings and there was imminent the possibility that large quantities of this good food might have to be destroyed for lack of markets, the demonstrators were detailed to the Middle West, to give a series of demonstrations in St. Louis, Chicago, St. Paul, Minneapolis, Cincinnati, and Cleveland. At these meetings housewives were encouraged to use frozen fish and were given instructions in buying and preparing them for the table. Stewards' associations, home demonstration workers, food-conservation officials, community-service organizations, and others were interested and benefited by the instructions given. The value of the work was well vouched for by the trade in its reports of increased demand for frozen fish, and many housewives commented on their previous failure to use such fish, believing them to be of poor quality, if not actually unfit for food. In May a successful series of demonstrations was held in Boston and Cambridge, Mass., after which the work was brought to a close for lack of funds.

To enable State and local agents of the States Relations Service of the Department of Agriculture to carry the benefits of this work to the housewives of their respective communities, demonstrations were given in St. Augustine, Titusville, Miami, West Palm Beach, and Key West, Fla.; at the Agricultural and Mechanical College of

Mississippi; in Savannah and Valdosta, Ga.; and before a gathering of State agents in Washington, D. C.

In all, some 125 demonstrations were given, the average attenddance being about 100 persons. In this work the Bureau was particularly fortunate in obtaining the services of a highly trained and skillful demonstrator, ably assisted by two persons, one of whom was a man with wide acquaintance with the fisheries. From every city in which demonstrations have taken place expressions of appreciation of their usefulness and importance have been received, and many women have acknowledged that they had been using little or no fish, largely because of some groundless prejudice, and have testified to the value of this work to them.

This entire program was made possible at a most opportune time by the use of money allotted by the President from the fund for the national security and defence. The total cost of the work was less than $12,000. It is with very great regret that announcement must be made of the failure of Congress to grant any money or authority for continuing this highly beneficent service.

## FISH-COOKERY EXPERIMENTS.

As an essential factor in the Bureau's campaign for inducing the wider use of aquatic products as food, more particularly those that have been wholly or partly neglected, an experimental kitchen has been equipped, and workers expert in domestic science have been employed to determine the best methods for preparing new or little-known fishery products for the table. The information assembled has in some cases been forwarded directly to the trade, in others it has been arranged for publication in the Bureau's economic circulars to further the use of particular products, In addition, a cookbook on aquatic foods has been prepared for publication.

## INCREASING THE USE OF WASTE PRODUCTS OF FISHERIES.

There is, on one hand, an increasing demand for new and enlarged sources of supply of protein feeds for hogs, cattle, and poultry, and of oils suitable for paints, varnishes, hydrogenation, and many other uses. Considerable quantities of fish waste and waste fish, on the other hand, which should be used to supply these deficiencies remain unutilized for lack of small, inexpensive plants suitable for caring for this waste, and because of lack of knowledge on the part of possible producers of apparatus and methods required and other difficulties by no means insurmountable.

The Bureau needs, and has made request for, the creation by Congress of a new position so as to permit the employment of a properly trained technologist to devote his entire time to these problems. Such work would annually result in the saving of fishery products possessing a value many times the cost of investigations. In the absence of proper provision for this work, the Bureau is attempting to render such service as its limited facilities will permit.

Encouragement has been given to manufacturers of fish scrap to convert all suitable material into fish meal as feed for domestic animals. Attention has been directed to the perfection of details of manufacture, and, as a result of these efforts, manufacturers in the Chesapeake Bay region are prepared to produce and market from 2,000 to 5,000 tons of this feed in the 1919 season, provided a sufficient number of users of such feed can be acquainted with its merits and interested to purchase it. In the development of markets and in acquainting farmers with the value of such feeds, the Bureau of Animal Industry of the Department of Agriculture is lending effective cooperation. It is also conducting hog-feeding experiments with meal made from fish and fishery products, as, for example, menhaden meal, grayfish meal, and shrimp bran, to determine their quality as compared with other feeds. Such tests as have been completed indicate that fish meal is fully the equal of tankage.

On the west coast, including Alaska, the increasing demand for fish meal is reflected in the rapid increase in production. According to the Pacific Fisherman, the production in 1916 amounted to 2,640 tons of meal and 776 tons of fertilizer, in 1917 to 5,297 tons of meal and 1,390 tons of fertilizer, and in 1918 to 7,773 tons of meal and 802 tons of fertilizer, all of which was inadequate to satisfy the demand. In 1918 the reported yield of the menhaden industry of the Atlantic seaboard was 16,017 tons of dried scrap, much of which it is believed could better have been made into fish meal, and 33,187 tons of acidulated scrap.

During the war fish oils commanded unusually high prices, followed by a decided drop after the signing of the armistice. As a result of the increasing demand for these oils, prices have since approached their former high level. The falling off of the flax crop, the lack of supply, and the abnormally high prices of linseed oil have compelled the paint industry to seek new sources of drying oils required in paints and varnishes. It is believed that in the future menhaden oil and possibly other fish oils will be more extensively used in making certain types of paints and varnishes. Investigations to determine the fitness of various fish oils for such purposes have been arranged for. It is estimated that the production of fish oils in the United States, including Alaska, in 1918 amounted to approximately 6,000,000 gallons, of which 3,943,100 gallons were menhaden oil, a considerable increase over 1917 for both items.

In addition to the foregoing work, the Bureau has given attention to the possibilities of increasing the use of shrimp waste, to the methods of handling fish waste and waste fish employed in California, and to assembling samples of meal and oil for chemical examination, and has furnished a large number of interested correspondents with literature on the subject, including extracts from various publications not readily obtainable, and has placed them in touch with manufacturers of machinery employed in the industry and with markets for the products.

## DEVELOPMENT OF AQUATIC SOURCES OF LEATHER.

The development of the aquatic leather industry, to which the Bureau has been giving considerable attention, has progressed satisfactorily. Nets of the special type developed by the Bureau for the capture of sharks and other powerful fishes are now being employed in taking these forms in commercial quantities. One leather company has established fishing plants at Morehead City, N. C., and Fort Myers, Fla., to provide regular supplies of shark hides for tanning purposes, and has a tannery for converting these into Another company has acquired a site at Edmonds, Wash., plans to tan and finish into leather all kinds of aquatic hides, sharks, whales, hair seals, etc. Other companies are experi with these products and will later engage in the industry.

Difficulty was at first experienced in removing the shagre shark skins in a satisfactory manner. Suitable methods ha been devised for doing this before the sharks are skinned and f cured skins as well, and the removal of the shagreen has al accomplished at the close of the tanning process.

Following the Bureau's suggestions, all parts of the shark being utilized. Besides using the skins for tanning into leat valuable liver oil is extracted and marketed, the remainder fish is converted into fertilizer or fish meal, and experime in progress to develop suitable methods of perserving the food purposes. The Washington Institute of Industrial R is cooperating with the Bureau to determine the fitness o grayfish, and skate-liver oil as a drying oil for making pa varnish. It is claimed that these products have sufficient support the fishery, thus permitting excellent leather to b from the hides at low cost.

According to the Bureau of Standards, which has been coo with the Bureau of Fisheries in this work, fish leather such made from shark skin has a more spongy and fibrous textu mammal leather. When pulled open at right angles to the it often exhibits a laminated structure similar in appearance of a loosely-matted felt. Material is being assembled to ena bureau to determine more definitely the qualities of fish leath as durability, pliability, porosity, water absorption, wearing q and to make further tests as to tensile strength. Tests the Bureau of Standards of such samples as have been su indicate that fish leather usually possesses less strength than leather, such as calfskin or cowhide, but that it is soft and and has ample strength for many uses. As the industry is expected that special uses will be found, dependent upon herent differences of hides from different fishes. One such which attention is being given is the employment of pieces of skin in place of the usual clip or fastener on garters, the small catching in the webbing of the stocking.

Leathers of excellent appearance and quality are now bein from porpoise hides, and it is believed that hereafter the these animals will be utilized, not wasted.

As the hides of the sharks give the greatest promise because abundance, and quality, the Bureau is continuing to devote attention to the development of the shark fishery and to dete definitely the properties of the various products and the which they are best adapted. It has been the practice of fis to operate most intensively for those fishes for which the de greatest and to permit such predatory forms as the sharks, po little or no value, to multiply and to increase their depredatio the more highly prized forms. This is an added reason for th opment of a fishery for sharks and of uses for the products.

## PRINCIPLES GOVERNING PRESERVATION OF FISH BY SALTING.

During the lack of proper laboratory facilities the Bureau, with the cooperation of the National Research Council, was enabled to carry on at Johns Hopkins University Medical School, Baltimore, Md., an investigation of the problems of preserving fish with salt, and Dr. E. V. McCollum kindly volunteered to supervise the work at that institution. Experiments were conducted later at fishing centers in Virginia, North Carolina, and Florida.

The primary object of the investigation was to devise an improvement in the present methods of salting fish and to find an acceptable way of salting fish at summer temperatures, particularly in the Southern States, where difficulty in the warm months is encountered.

Incidentally, the work has added materially to our knowledge of the basic principles governing the salting process. The fish used in the experimental work were squeteague and river herring. The rate of penetration of salt into fish and the decomposition of the protein, as indicated by the amount of amino-acid nitrogen formed, were used as criteria of the efficiency of salting methods.

Sulphates and also salts of calcium and magnesium, as impurities in common salt, were found to retard the penetration of salt into fish muscle, but to produce a firmer, whiter flesh than pure sodium chloride. By reason of retarded penetration, salt containing these impurities permits fish to spoil at a lower temperature than salt not containing such impurities. Of these deleterious substances, the calcium salts are the only ones present in commercial salt in a large enough quantity to have a marked effect on the quality of the fish.

The removal of all blood and viscera, including roe and milt, appears to be an important factor in the salting of fish in warm climates. Experiments made indicate that the blood spoils at a temperature at least 25° F. lower than the spoilage temperature of the flesh of fish.

An investigation of the chemical changes taking place in the fat and protein of fish during storage is in progress, and a report of the completed work is being prepared for publication.

## DEVELOPMENT OF A PROCESS FOR RECOVERY OF WASTE BRINE.

It has been the usual practice among fish curers to discard the used brine employed in brine-salting fish, and also to some extent in the dry-salt process, and to make new brine for new lots of fish. Much salt has been wasted, the recovery of which was impracticable for a number of reasons. For example, the brine is loaded with a large amount of organic matter, blood, mucus, soluble proteins, methylamines, bacteria, etc., whose removal would be expensive; and, since salt was comparatively cheap and used in large quantities, any recovery process must of necessity produce results at low cost.

Recent investigations of the Bureau have shown that a better quality of fish may be produced by using higher grades of salt and have indicated the possibility that salting could be successfully accomplished in warmer climates. Without some recovery process the cost of refined salts may be prohibitive.

For these reasons the Bureau undertook to develop a process of purifying fish brine without expensive evaporation. Advantage was taken of the adsorption by exceedingly fine precipitated particles of a tasteless and inert substance of the suspended and dissolved organic matter, which is subject to decay. It has been demor that the precipitate does remove most of the organic matter plant has been installed in a fish-packing establishment at Glo Mass., for trial. If this recovered brine can be rendered suit use again, the old brine used in preserving the fish brought plant will, when recovered, supply most of the salt needed fo use. At the present time, when the price of salt is about $16 as compared with $3 three years ago, this is an item of impo The recovery process provides for the filtering off and dryin precipitate, a product rich in protein which may be convert fertilizer or fish meal. It is expected that this process, in conj with improved methods of salting requiring high-grade salt, t reference has been made, will mark an advance in salting m The development of a practicable recovery process should the fish trade to use high-quality domestic salts in place o foreign grades.

As this work is still in the experimental stage, the results, in complete description of details of apparatus, will not be d until the practicability of the method has been satisfactorily strated.

## URGENT NEED FOR EXHAUSTIVE INVESTIGATIONS OF PI ING METHODS.

In no branch of the fisheries is there greater need for exh study than in the methods of preservation of fishery product methods in common practice are largely empirical, and in man the basic principles governing the operation are not definitely There is waste of time, labor, fuel, and materials, and the remain undeveloped from the lack of knowledge of suitable m To solve problems which in many cases are of vital import the welfare of communities, well-equipped fishery-products tories and a well-trained corps of skilled technologists are re With adequate provision for these it would be possible to many important investigations under accurately controlled co and render inestimable service in developing the fishery ind To appreciate the handicap under which the fisheries labor, but to recall how amply agriculture is supplied with both Fede State experiment stations, with skilled investigators and turists trained in colleges and universities provided for the p and how greatly it has benefited thereby, while the fisheri utterly lacked any such advantages, and their development consequence been retarded. During the past year provision h made for one such laboratory for the Bureau, and one univers established a college of fisheries in which the methods and p of the fisheries will receive careful study and a corps of stude be trained for the industry.

## FISHERY PRODUCTS LABORATORIES.

Through an allotment of $125,000 from the fund for the n security and defense, approved and authorized by the Presi July 2, 1918, the Bureau has been enabled to build a fishery-p laboratory in Washington, D. C., to provide equipment, initiate investigations of importance to the industry.

The building is 45 by 80 feet, with two floors and an attic, and is of hollow-tile and concrete construction. On the first floor there are a large mechanical laboratory, low-temperature rooms for storage and refrigeration, chemical laboratory, incubation room, stock room, and a built-in smokehouse. On the second floor there are a laboratory, a fishery-products exhibit and demonstration room, an experimental kitchen, and offices.

The mechanical laboratory contains equipment for the canning, freezing in brine, drying, and smoking of fishery products, hydraulic press, filter press, grinder, steam boiler, vacuum and compressed air pumps, and various other appliances. For canning purposes there are a complete plant for sealing the cans by a double seamer, a retort with controlling and recording instruments, complete apparatus for sealing and processing glass containers by a vacuum process, and another apparatus for processing tin containers, also by a vacuum process. In the experimental drier the heat, humidity of the air, and volume of air driven over the product can be controlled and registered and the weight of the material can be recorded, so that the exact conditions governing the drying of various fishery products may be worked out. An experimental plant for freezing fish in brine has been imported from Denmark and has been shown to persons interested in refrigeration. This plant, which was the first of its kind to be brought to and used in this country, enables the Bureau to demonstrate to the trade a new method and to afford the scientific staff of the laboratory a means of investigating the various types of brine freezing and comparing them with the customary freezing in air. The built-in smokehouse is of hollow-tile and cement construction, lined with white, glazed wall tile, provided with a flue, iron door, ventilators, shaving pans heated with gas, long-distance recording thermometer, and dampers for control of heat and ventilation.

The refrigeration plant is equipped with a 5-ton carbon-dioxide machine, and three rooms of different temperature are provided. The chemical laboratory is supplied with soapstone furniture, improved cabinets for classifying and holding chemical stock, viscosimeter, refractometer, polarimeter, colorimeter, specific-gravity balances, supercentrifuge, apparatus for determination of amino groups, apparatus for gas analysis, and other equipment needful for chemical study of materials and processes. That the factors which influence the character of the product may be known, measured, and controlled, provision has been made for recording hygrometers and thermometers, thermostats, pitot tubes, and pressure and vacuum gauges.

In the absence of a laboratory of this kind for a guide, much study and effort had to be expended in working out plans and details of equipment. The building was completed during the year, and several important investigations therein have already been instituted.

This laboratory has been planned and equipped for the study of the general problems of the industry, to enable its investigators to try out new methods and suggestions for improvement of common practices, and to overcome difficulties encountered in the field. It is intended for a workshop in which the properties of fishes and fishery products may be subjected to careful and thorough investigation and uses developed therefor, a place in which to perform the manifold examinations and analyses demanded of this Bureau in the interests of the fisheries.

There is need for other similar laboratories in or near an important fishing center in each of the main geographical divisions of the country, for the study of the special problems of those divisions, for the conduct of investigations which can only be conducted at the seat of the industry, and for aiding in the perfection of apparatus and methods used in the capture, preservation, and preparation for market of the fishes of the region. The work of each of such laboratories should be under the direction of the Washington laboratory and coordinated with it and with the laboratories in other centers.

On the coast of California there is now special need for work in this field. Although noteworthy progress has been made in the development of its fisheries, for example, those for tuna and sardines, there are still large, undeveloped fishery resources in the barracuda, mackerel, rockfishes, etc. Desirous of lending assistance to the fishery industries of this region, provision has been made for a temporary laboratory for the study of some of the more pressing problems.

After some six weeks study of the advantages of the various fishing centers of southern California, suitable temporary quarters in San Pedro were obtained for the establishment of a small experimental plant. The equipment of this plant was completed within three months, and during May and June, 1919, investigations in the canning of mackerel, barracuda, rockfishes, smelt, pilchards, and tuna were initiated. According to a schedule which has been worked out, each species is subjected to 16 preliminary methods of packing, all of which may be run at one time. At the conclusion of the canning the packs are subjected to uniform storage conditions. At the end of six weeks these preliminary packs are examined as to firmness, appearance, taste, quality, etc., and analyzed to determine whether there has been a chemical change. Adopting the methods of the most promising of the preliminary packs, finished packs—that is, packs to which condiments or special packing oils have been added or in which the fish is subjected to some special treatment—are next put up. These final packs range from the simplest and most inexpensive to the most complicated and exclusive form of treatment. In order to determine the keeping qualities of the various methods with reasonable certainty, it is planned to examine samples at the end of 3, 6, and 12 months. If the product is in good condition and excellent in quality at the end of a year, it is felt that the process may be given to the trade. Careful records are kept of all operations and of the weight and amount of ingredients used. If the market price of ingredients is known, it will be possible at any time to determine the cost per case. Perhaps the most promising of the packs made during the year were those of the mackerel packed in olive oil, tuna style, and kippered and canned in cottonseed, corn, or olive oil. This species, generally known on the east coast as chub mackerel, is reported to be very abundant, but owing to the limited demand comparatively small quantities are now brought in by the California fishermen.

## NEW ENGLAND VESSEL FISHERIES.

The vessel fisheries at Boston and Gloucester, Mass., and Portland, Me., the three principal New England fishing ports, were more than ordinarily prosperous during the calendar year 1918, notwithstanding the presence of enemy submarines along the coast and on the fishing grounds for some time during the summer and the consequent loss of a number of fishing vessels. This condition was due largely to the increased demand for fishery products and the prevailing high prices during the war period.

The fishing fleet discharging at these ports in 1918 comprised 521 sail, steam, and gasoline screw vessels. They landed at Boston 2,830 trips with 109,476,041 pounds of fish, valued at $6,587,754; at Gloucester 3,414 trips with 74,175,499 pounds, valued at $3,062,605; and at Portland 2,506 trips with 21,849,613 pounds, valued at $881,189; a total of 8,750 trips and of 205,501,153 pounds of fresh and salted fish, having a value to the fishermen of $10,531,548. This total includes 60 trips landed at these ports by 21 Canadian fishing vessels, amounting to 5,602,749 pounds of fresh fish, valued at $218,625. These fish were landed in accordance with an arrangement with the Canadian Government, as an emergency war measure, granting reciprocal privileges to fishing vessels of both countries, one feature of which was that Canadian fishing vessels were permitted to land their fares at American ports directly from the fishing grounds. Canadian fishing vessels began to utilize this privilege in April and continued during the remainder of the year. The larger part of these fish, or 4,668,620 pounds, valued at $164,946, were landed at Portland.

There was a decrease of 534 trips in the total number for the three ports as compared with the previous year, but an increase of 30,070,567 pounds, or 17.14 per cent, in the quantity, and of $2,170,216, or 25.95 per cent, in the value of the fish landed. The catch of cod increased 27.19 per cent in quantity and 52.57 per cent in value; haddock, 24.49 per cent in quantity and 27.12 per cent in value; and pollock, 83.07 per cent in quantity and 66.08 per cent in value. The catch of halibut increased less than 1 per cent in quantity, but had 37.88 per cent greater value. There was considerable falling off in both the quantity and value of hake, cusk, mackerel, swordfish, and tilefish.

The fishery products landed at these ports by fishing vessels each year are taken principally from fishing grounds lying off the coast of the United States. In the calendar year 1918, 68.10 per cent of the quantity and 70.86 per cent of the value of the catch landed by American and Canadian fishing vessels were taken from these grounds; 4.36 per cent of the quantity and 4.70 per cent of the value were from grounds off the coast of Newfoundland; and 27.52 per cent of the quantity and 24.43 per cent of the value, from fishing grounds off the Canadian Provinces. Newfoundland herring constituted 3.10 per cent of the quantity and 3.15 per cent of the value of the products landed during the year. The herring were taken on the treaty coast of Newfoundland, and the cod and other species from fishing banks on the high seas. All fish caught by American fishing vessels off the Canadian Provinces were from offshore grounds.

*Cod.*—Cod ranked first in importance in both quantity and value, the catch, fresh and salted, amounting to 71,824,427 pounds, valued at $3,617,205.

*Haddock.*—The catch of haddock ranked second to that of cod, amounting to 66,671,541 pounds, valued at $3,199,276.

*Hake.*—The yield of hake has fallen off in the past few years. In 1918 the catch was 5,280,829 pounds, valued at $273,085. In 1916 over 13,000,000 pounds were taken, and in 1910 the quantity landed at Boston and Gloucester alone was nearly 20,000,000 pounds.

*Pollock.*—The pollock catch was much larger than usual, the quantity landed being 26,560,620 pounds, valued at $962,085.

*Cusk.*—The output of cusk was small as compared with recent years, amounting to only 2,658,260 pounds, valued at $103,031. The catch of this species has usually been about three million to upward of six million pounds.

*Halibut.*—The catch of halibut was 1,781,004 pounds, valued at $302,280, which was 14,940 pounds more than in the previous year, with $83,048 greater value.

*Mackerel.*—The total yield of fresh mackerel taken by the American fleet in 1918 was 69,314 barrels, compared with 111,932 barrels the previous year, a decrease of 42,618 barrels. The catch of salted mackerel was 13,030 barrels, as compared with 32,162 barrels the previous year, a decrease of 19,132 barrels. The aggregate quantity of mackerel landed at Boston, Gloucester, and Portland by the fishing fleet during the year was 10,158,467 pounds, valued at $1,188,924, of which 7,582,414 pounds, valued at $853,639, were fresh, and 2,576,053 pounds, valued at $335,285, were salted. This quantity includes 29,152 pounds of fresh mackerel, valued at $2,423, from the Cape Shore, landed by Canadian vessels.

In 1919 both the purse seiners and gill netters in the mackerel fishery had a comparatively good season. The mackerel landed by the southern fleet were mostly large and medium fish, and sold from 8 to 18 cents per pound, according to market conditions. The total catch of mackerel up to July 1 was 38,787 barrels fresh and 6,452 barrels salted, compared with 29,259 barrels fresh and 8,079 barrels salted the previous year.

## PACIFIC SALMON FISHERIES.

Outside of Alaska the Bureau's connection with the salmon (and other) fisheries of the Pacific seaboard consists of very extensive cultural operations addressed to the salmons in all the coastal States, biological and other investigations of the salmons and salmon waters, and interest in the welfare of the vast industry dependent on the salmon supply.

The conduct of salmon culture is, by law, contingent on the enforcement by the States of measures for the adequate protection of the salmons, so that the money and effort devoted to the work of artificial propagation may not be wholly or partly vitiated. The question has arisen as to whether certain practices of the salmon fishermen are needlessly wasteful and destructive. If the answer is affirmative, remedial action by the States is clearly demanded if the Bureau is to continue the operation of its hatcheries.

A feature of the salmon fisheries which has attracted much attention in recent years and has been widely discussed is the taking of salmon by lines and nets at sea, on the feeding grounds of the schools, under conditions that necessarily involve the destruction of large numbers of immature fish on which the future of the industry depends. This practice which for years has been followed in Monterey Bay, Calif., has more recently been taken up and very actively engaged in off the Columbia River, off the Strait of Juan de Fuca, and to a less extent in other sections.

The Bureau conducted an inquiry into this matter by a biological assistant who is devoting his entire time to Pacific salmon problems, and in August, 1918, made known the results of the inquiry. The following data are extracted from the published report:

In Monterey Bay chinook salmon are taken exclusively by troll, and a large percentage are immature. Accurate figures are not yet available, but well over 50 per cent of the fish seen at Monterey are distinctly immature. This is shown by the age as determined by the scales, by the size of the fish, and by the size of the eggs in the ovaries.

Off the mouth of the Columbia River within the past four years trolling and purse-seining have increased rapidly. Four years ago there were no purse seines and but few troll boats operating in this section, probably not more than 20 or 30. In 1918 there were several dozen purse-seiners and probably 2,000 trollers fishing just outside the mouth of the river. An examination of some of the fish brought in by this gear disclosed many immature specimens among them, although these constituted a rather small proportion of the catch at the time the examinations were made, August 12 and 13. However, at one of the canneries at Astoria there was about a ton of small fish which had been taken by troll, called locally "grayling," and a cursory examination showed that they they were practically all immature. It should be noted that all reports available, derived from various sources, agree that the proportion of small, and presumably immature, fish is much greater earlier in the season, particularly during May and June.

Outside the Strait of Juan de Fuca purse-seining has been carried on for a number of years. Silver salmon constitute a large proportion of the catch. The center of the industry is at Neah Bay. A report by Dr. Charles H. Gilbert ("The Salmon of Swiftsure Bank," 1913) contains a description of the fish taken here and shows that the majority are more or less immature.

Practically all of the fish taken thus by troll and purse seine in the open ocean are feeding and their stomachs are full of food. Within a few hours after they are taken from the water auto-digestion sets in and the fish soon become soft. The ribs loosen and the bellies frequently become so soft that they break through. Such fish are spoken of as being "belly-burned." At Monterey this is not a serious matter, so far as our observation goes, as the fish are delivered soon after being caught. In the Columbia River and Puget Sound regions, however, the fish are frequently in poor condition before they are delivered. The small fish seen in Astoria were in very poor condition and appeared hardly fit for human food. They were soft and badly "belly-burned" and the odor arising from them was most unpleasant.

The economic waste resulting from this fishing may be summarized as follows:

1. *Waste resulting from the taking of fish before they have attained full size.*—A large number of these fish lack one, two, three, and even four years of being mature, and in this time would increase to from twice to 20 times the weight when taken. This loss may be to some extent offset by the fact that fish are taken which before reaching maturity would fall prey to enemies other than man. There must be, however, comparatively few fish of the size taken

by trollers and purse seiners which would thus be captured by predacious animals. The results of the marking experiment with Yes Bay sockeyes on the Columbia River indicate that between 5 and 10 per cent returns may be expected from 4-inch fish planted in fresh water approximately 150 miles from sea. It seems very unlikely, therefore, that any considerable loss takes place after the fish have migrated, become accustomed to life in the ocean, and reached a size of from 1½ to 10 pounds. Undoubtedly a very high percentage of such fish would survive until fully mature. The taking of these fish before they reach full size is nothing less than sacrificing large future returns for much smaller immediate returns, and, as already shown, the quality of these smaller immediate returns is low.

2. *Waste resulting from the spoiling of fish.*—The poor condition in which many fish taken in the open ocean reach the packing houses has previously been commented on. At the best, this must result in a poorer quality of food and at the worst the salmon become so foul that even the most unscrupulous packer will discard them—a total loss. In cleaning the small fish, those below 5 pounds in weight, the butchers usually cut the body just back of the pectoral fins instead of removing merely the head, as is customary in cleaning the larger fish. Although there are no accurate figures bearing on this, the practice must increase the waste due to cleaning from about 25 to 40 per cent.

3. *Waste resulting from the injury of fish hooked but not landed.*—This is undoubtedly much larger than is generally supposed. No data are available, and they would be difficult to obtain. Not infrequently, however, the fishermen report that they have lost as many as they landed. A conservative estimate would perhaps be 2 fish lost for each 10 landed. Fish which have been hooked are frequently taken by gill nets and traps within the Columbia River. Occasionally the hook and spoon is found embedded in the jaws, but more often the jaws are split and badly torn. Many of the fish hooked and lost undoubtedly die, but what percentage is unknown.

The Bureau duly brought this subject to the attention of the fishery officials of the States of California, Oregon, and Washington, and assured them of its desire to assist them in any feasible manner in meeting this menace to the salmon industry. Up to the writing of this report the Bureau has received no request for assistance and is not advised of any remedial measures that have been adopted by the States concerned.

## VESSEL FISHERIES OF SEATTLE.

The fishing fleet at Seattle, Wash., landed 834 trips during the year 1918, consisting of 17,091,695 pounds of fresh fish, having a value to the fishermen of $1,887,653, from the fishing grounds along the coasts of Oregon, Washington, and Alaska. The largest quantities were taken from Gray's Harbor Grounds, Flattery Banks, west coast of Vancouver Island, Hecate Strait, and Portlock Bank. The products included halibut, 10,244,200 pounds, valued at $1,528,846; cod, 85,300 pounds, valued at $2,202; sablefish, 4,354,950 pounds, valued at $271,167; "lingcod," 1,784,600 pounds, valued at $62,292; rockfishes, 620,770 pounds, valued at $22,899; and sturgeon, 1,875 pounds valued at $247. Compared with the previous year, there was an increase of 214 trips by fishing vessels, and of 2.64 per cent in the quantity and 8.56 per cent in the value of the products. The catch of halibut was not so large as in the previous year, but there was a notable increase in the production of sablefish, "lingcod," and rockfishes.

The fishery products taken in Puget Sound and landed by collecting vessels during the year amounted to 10,605,323 pounds, valued at $912,598. This quantity included 8,929,745 pounds of salmon, valued at $811,028, and the remainder consisted of steelhead, herring, smelt, flounders, sole, crabs, and various other species. Compared with the previous year, there was a decrease in the products landed by collecting vessels of 17.28 per cent in quantity and 7.68 per cent in value.

### FISHERIES OF GREAT LAKES, LAKE OF THE WOODS, AND RAINY LAKE.

A canvass of the fisheries of the Great Lakes and certain contiguous waters for the calendar year 1917 was completed by the Bureau during the past fiscal year. The fisheries of the Great Lakes were ascertained to have employed 9,221 persons, the investment was $10,555,669, and the products amounted to 103,759,223 pounds, valued at $6,297,969. The principal species taken, including fresh, salted, and smoked fish, were carp, 7,163,347 pounds, valued at $334,888; ciscoes, 53,429,325 pounds, valued at $2,609,917; "blue pike," 2,102,803 pounds, valued at $140,025; "wall eyed" 2,496,691 pounds, valued at $298,271; sauger, 3,929,172 pounds, valued at $240,035; sheepshead or drum, 2,901,994 pounds, valued at $70,936; suckers, 5,361,138 pounds, valued at $204,825; lake trout, 13,325,389 pounds, valued at $1,285,085; whitefish, 6,190,748 pounds, valued at $723,167; and yellow perch, 4,206,011 pounds, valued at $245,223. With the ciscoes are included lake herring, chub, longjaw, bluefin or blackfin, and tullibee.

Compared with the returns for 1908, published by the Bureau of the Census, there was an increase of 8.06 per cent in the number of persons engaged and of 119.27 per cent in the investment, but a decrease of 2.69 per cent in the quantity with an increase of 67.14 per cent in the value of the products. Compared with the statistics for 1903, collected and published by the Bureau, there was a decrease of 1.20 per cent in the number of persons engaged, an increase of 41.22 per cent in the investment, and an increase of 20.37 per cent in the quantity and 129.39 per cent in the value of the products.

In the fisheries of Lake of the Woods and Rainy Lake, including Lakes Kabetogama and La Croix, 195 persons were engaged; the investment was $177,210; and the products amounted to 2,167,169 pounds, valued at $118,508. The principal species taken were ciscoes, whitefish, pike, pike perch ("wall-eyed pike"), and suckers.

## BIOLOGICAL INQUIRY.

### STUDY OF FISHES.

*Salmon investigations.*—There are so many significant questions concerning the habits, migrations, and propagation of the salmons in Pacific States and Alaska that the Bureau has long felt it desirable to attack their solution in a more adequate manner. With the beginning of the last fiscal year a special assistant was engaged for continuous study of the habits of salmon entering streams of the Pacific States. The investigations previously undertaken in Alaska have also been continued. While the investigations in Alaska have been productive of some results which it has been possible to apply with profit in the fish-cultural operations and in the fishery regulations in that section, they must be continued for a further period before results of such definite character are secured as to warrant the publication of a report. The Bureau has now in hand a report presenting the data previously accumulated as bearing upon the migrations and growth of young salmon in the Sacramento and Columbia Rivers.

In the course of the year special biological inquiries were directed to the salmon taken in trolling and purse-seining operations off the coasts of Washington, Oregon, and California. The practical application of the ascertained facts to the regulation of the fishery is elsewhere referred to.

One of the results of the hearings of the American-Canadian Fisheries Conference in Seattle and Vancouver was an arrangement to conduct a joint investigation of the rate of migration of sockeye salmon from salt water into the Fraser River. Early in July, 1918, marking experiments on a large scale were undertaken by representatives of the Bureau of Fisheries and the Canadian Government in cooperation. Although the run of this species was very light that year, more than 4,000 fish were tagged and liberated, and a considerable number of these were subsequently recovered. Results of notable interest and practical importance were obtained and are covered in a report which is in course of publication.

Special interest also attaches to the results gained during this fiscal year from experiments in marking young sockeye salmon planted in the Columbia River in the spring of 1916. At that time about 50,000 yearling sockeyes hatched from eggs received from the Yes Bay (Alaska) hatchery and reared in ponds of the State hatchery at Bonneville, Oreg., were marked and liberated in the Columbia River. Salmon of this species have been found to return in the fourth and fifth years. Many of the marked fish returned during the summer of 1918, the fish being then in the fourth year of life. The marked fish recovered in the Columbia River (being of Alaskan stock) were found to be distinctly different in size and general appearance from the Columbia River bluebacks, representing the identical species, but resembling in every way the fish from the Yes Bay region, where the eggs were taken. Salmon of the Yes Bay type average about 6 pounds, whereas the Columbia River bluebacks this year averaged about 3 pounds. The large size of these fish is particularly significant as indicating that for at least one generation heredity rather than environment determines the size of the fish. This opens prospects for improvement in the quality of the run of fish through carefully conducted cultural operations.

*Pilchards on the northwest coast.*—During January, February, and March, 1919, a preliminary inquiry was conducted into the occurrence of pilchards on the northwest coast suitable for canning as sardines, especial attention being given to the following localities in Oregon and Washington: Coos Bay and Coquille River, Umpqua River, Yaquina Bay, Alsea Bay, Siletz River, Tillamook Bay, Netarts Bay, Columbia River, Willapa Harbor, and Grays Harbor.

It was learned that somewhat irregular runs of pilchards occur generally along the coast from April to October, especially in the regions of Coos Bay and Umpqua River. While it is believed that the fish are eminently suitable for canning as sardines or otherwise, the Bureau has not felt that the general trade conditions existing in the canning industries justified its giving immediate encouragement to new ventures in the canning of fish on the northwest coast or elsewhere. It is expected that further inquiries and observations may be made at an appropriate season.

*The paddlefish.*—One of the important fishes of the Mississippi Basin which is diminishing in numbers and seems threatened with extinction is the paddlefish, which is valued to some extent for its flesh but principally for the roe, which is useful for preparation as a relatively high grade of caviar. Up to the present time it has never been possible to secure definite information regarding the breeding habits of this fish. Realizing that a special effort must be directed at this problem before it may become too late, the Bureau, in cooperation with the conservation department of Louisiana, undertook a special study of the breeding habits and propagation of the paddlefish during the latter half of the fiscal year under report. Definite results were not secured, but it is believed that a groundwork was laid which may contribute toward solution of the problem with further attempts. Meantime it is interesting to record that experiments initiated at the fisheries biological station at Fairport, Iowa, in 1914, have shown that the paddlefish will live and grow for periods of years while inclosed in an artificial body of water such as the storage reservoir of the station.

*Spawning of squeteague.*—An investigation into the spawning habits and condition of the squeteague in Delaware Bay was conducted in May and June, 1919. It was found that spawning began a little before the middle of May and continued until the middle of June or later. Many fish were examined, townet hauls for the floating eggs were made, and temperatures and salinities were determined.

This body of spawning fish supports an extensive gill-net fishery, which is pursued in small skiffs, the New Jersey law limiting each boat to the use of 50 fathoms of gill net. Experiments were made in the artificial fertilization of eggs from the fish thus taken; this proved to be entirely feasible, and the eggs so fertilized were returned to the water directly on the grounds.

It is evident that it would be productive of good results if the commercial fishermen should become educated to the desirability and advantage of saving the ripe eggs from fish taken for market during this season, fertilizing the eggs and returning them to the water.

## FISH IN RELATION TO MOSQUITO CONTROL.

In a previous report mention is made of the practical services rendered by this Bureau in cooperation with the Bureau of Public Health Service in protecting the health of soldiers in Army cantonments. A report of investigation and operations conducted in the vicinity of Camp Hancock has been published conjointly by the two bureaus.

In an effort to determine as precisely as possible the conditions of effective control of mosquitoes by fish, the Bureau has continued its cooperation with the Bureau of Entomology at Mound, La., where experiments are conducted looking to the improvement of health as regards malaria in rural communities and to the protection of farm labor in the South.

Experiments of like nature are being prosecuted in northern waters where, though mosquito-borne diseases are less prevalent, nevertheless the economic losses attributable to the prevalence of mosquitoes are of great significance.

## EXPERIMENTAL FISH CULTURE.

Previous reports have dwelt upon the importance of fish-cultural experiment work and the progress in this field which has been made in connection with fisheries biological station at Fairport, Iowa. The experiments and investigations have continued to show favorable progress, and at the close of the fiscal year the Bureau had taken steps to apply some of the results hitherto gained at Fairport for the improvement of pond fish-cultural operations at several of its regular stations. The field of experimental work in fish culture is so broad, so complex, and so little surveyed, that it is a matter of regret that the means are wanting for the effective prosecution of studies of this character under the very diverse conditions encountered in different parts of the country and with reference to a greater number of species of fish.

## SHELLFISH INVESTIGATIONS.

*Oysters.*—The problems of oyster culture continue to be of such critical importance that the Bureau has been impelled to devote to their solution as great a measure of its resource as could legitimately be applied to one object. While the investigations have not been localized more than was essential for the accomplishment of useful results, the primary seat of activities has been in the vicinity of Milford, Conn., where a temporary field laboratory is maintained for studies of the oyster.

Examination of the waters of this region revealed the fact that a large number, perhaps more than half, of the leased grounds have ceased to be worked because of the small yield of oysters thereon, which is due, in turn, to the general failure of set. The strike of set during the past two years has, in fact, been practically negligible. Consequently, the investigation has been directed primarily toward ascertaining the cause of the failure of the set.

Following suggestions arising from earlier investigations, it was endeavored in 1918 to work out suitable methods for following up the movements of the oyster larvæ with the view of ascertaining just where to place cultch immediately before the time for spatting or setting to occur. The centrifugal machine used during the season of 1917 for separating larvæ from the water was largely superseded this year by a series of screens or sieves of copper-wire cloth of successive stages of fineness from 40 to 200 meshes to the inch. Passing samples of water through the sieves seems to yield as satisfactory results as the centrifuge in separating the oyster larvæ from other objects of different sizes, besides possessing the advantage of roughly classifying the larvæ according to size and age.

The first free-swimming larvæ were found July 16, 1918; the period of greatest abundance was from August 9 to 26, and none was observed after August 30. As the larvæ were found to be free-swimming for a period of about 20 days, it is evident that the bulk of the spawning occurred about August 1. Set was found during the last week in August on most of the beds in water not over 4 or 5 fathoms deep, but practically all of this set died except that which attached in the very early part of the season.

A tentative conclusion drawn from this investigation is that it is of prime importance to secure an early setting, such as results from the spawning of oysters in the shallow and warmer waters of harbors and mouths of rivers. Since it is just such beds that are generally most affected by pollution in the form of sewage and trade wastes, which may be fatal to the life of the free-swimming larvæ, it is evident that the matter of the possible effect of pollution on the occurrence of oyster set demands serious consideration. With the cooperation of the water laboratory of the Bureau of Chemistry studies have, therefore, been undertaken with regard to the nature and the effect of the pollutants introduced in the shallow waters.

Further investigations relating to the natural propagation of oysters have been conducted in Great South Bay, Long Island, and Narragansett Bay, R. I.

A very serious condition has manifested itself in oyster beds of a large section of the York River in Virginia, where for several years the oysters have been rendered virtually valueless for market. Examinations of the oysters, begun in November, 1918, revealed the fact that they were affected with a green coloration associated with watery and lean meats. This condition is quite distinct from that known as "green gill" and does not appear to be in all respects of the character of greening which in other localities has been attributed to the storage of copper. No cause has yet been found for the condition observed, which is, perhaps, a very indirect result of disturbance of environmental conditions. The investigation is still in progress, and the Bureau expects to continue it by regular periodic observations for such period of time as may be necessary to arrive at definite conclusions. Since chemical problems are involved, the Bureau has enlisted the cooperation of the water laboratory of the Bureau of Chemistry in the further prosecution of the study.

A poor condition of oysters presented itself, likewise, in Apalachicola Bay during the early winter. After careful investigations were conducted by the Bureau, the condition was attributed to a deficiency of rain in preceding months. At a later time, and after a period of increased rainfall, it was learned that the oysters had fattened and resumed a normal condition.

Late in the fiscal year the Bureau was enabled to undertake at slight expense, by cooperation with the New Jersey State Agricultural Experimental Station, a study of the feeding, growth, and propagation of oysters in the vicinity of Barnegat Bay.

The service of the Bureau to the oyster industry has been rendered more effective by the cooperation extended by several State departments, notably in Connecticut, Maryland, New Jersey, New York, and Rhode Island.

*Sea mussels.*—The sea mussel is one of the largely unutilized resources of the North Atlantic coast. While it has not been difficult to create a demand for sea mussels properly prepared, and while some packers have been interested to preserve mussels for market, difficulties have been encountered in obtaining at the right time an adequate supply of mussels in condition for use. During the fiscal year 1918, the Bureau conducted a reconnoissance of the mussel beds of the southern coast of New England and along the shores of Long Island Sound. In the fiscal year 1919 a similar investigation was made on the coast of Maine, with valuable aid from the commission of sea and shore fisheries of Maine. A summary of the results as reported by the investigator may be given:

1. A survey of the mussel beds lying near low-tide level was made between Portland and Eastport. The most important beds were centered in six regions: Casco Bay, Medomak River, St. George River, Deer Isle, Frenchmans Bay, and Jonesport.
2. Within these limits more than 1,200 acres of natural mussel beds were located which were estimated to yield 1,279,000 bushels. Not more than 10 per cent of this area supported a growth of first-class, marketable shellfish. The rest of it was covered with a small, undersized stock of poor quality that would never amount to anything unless transplanted to deeper water and more advantageous situations.
3. The best beds lie at or below low-tide mark and yield from 2,500 to 5,000 bushels per acre.
4. Artificial cultivation, by transplanting young or seed mussels from beds situated between tide marks to areas in deep water, where conditions are favorable for growth and fattening, would result in an enormous production of marketable shellfish.
5. There is no oyster industry on the Maine coast with which a mussel industry might conflict.
6. The water of the bays and estuaries on the Maine coast is unusually pure and free from pollution, which makes them most desirable areas for the production of marketable mussels.
7. There is a small demand for Maine mussels in Chicago which is being supplied from the beds in Frenchmans Bay.
8. Several of the leading packing houses located on the North Atlantic coast are interested in the canning of mussels and are taking steps to put the product on the market. They should be encouraged in this effort by help in solving the problems that arise in the handling and preserving of the shellfish and by advertising any products of real merit that are produced.
9. It is believed that the development of a mussel fishery is a practical thing and that it will add considerably to the wealth and food supply of the Nation.

*Fresh-water mussels.*—The investigations and experiments bearing upon the propagation of fresh-water mussels, conducted in connection with the fisheries biological station at Fairport, have continued to yield valuable results. One of the most significant experiments was conducted in the Mississippi River at Lake Pepin during the summer of 1918, when fish, after infection with the glochidia of fresh-water mussels, were kept in an inclosure 12 feet square, erected in shallow water in the lake. This small pen was provided with a board bottom over which a thin layer of sand was laid, and after it was placed in water of suitable depth in the lake it was stocked with

172 fish of various species bearing an artificial infection of glochidia of the Lake Pepin mucket (*Lampsilis luteola*). Seventy-nine of the fish were retained in good condition beyond the period of 14 days regarded as necessary for the completion of the stage of parasitism. In all, 11,199 living young Lake Pepin muckets were taken from the pen on September 23 (besides 502 individuals removed on previous dates). This represented an average yield of a little over 80 living mussels per square foot in addition to a few of other species resulting from natural infection. This experiment is of much significance as bearing upon the success of the artificial propagation of the Lake Pepin mucket.

*Miscellaneous studies of shellfish.*—While it has not been feasible to continue actively the investigations of the blue crab which have been so successfully prosecuted in the fiscal years immediately preceding, the Bureau has completed reports dealing with the blue-crab fishery of the Chesapeake Bay and with the life history of the blue crab. These reports, which were in process of publication at the close of the fiscal year, will undoubtedly be of material value to State authorities concerned with the protection of the crab and the preservation of the fishery in undiminished force. It has been gratifying to learn that a greatly increased catch of blue crabs in these waters has ensued, in consequence, as it is believed, of wise protective measures based in great part upon the results of the Bureau's investigations.

At the Key West, Fla., biological station, inquiries into the habits and growth of the spiny lobster have been continued, and upon the basis of useful information furnished to the State authorities of Florida, more effective protective measures have been enacted into law.

Through the cordial cooperation of the United States National Museum, the Scripps Institution for Research at La Jolla, Calif., and the California Fish and Game Commission the Bureau was enabled, at scant cost, to conduct investigations into the life history of the spiny lobster of the southern coast of California. Results of substantial interest were obtained.

The Bureau also continued, during a portion of the fiscal year, its examination into the shellfish resources of the northwest coast.

## AIDING PRODUCTION AND PREVENTING WASTE.

In view of the shortage of food supply which has confronted the country, the Bureau deemed no service more important than that which could be rendered to combat conditions responsible for losses of preserved fish or wastage due to a lack of coordination of supply and demand, in addition to preventing waste of surplus catches of fish and bringing new species of fish into the market. Some of these problems could best be attacked by methods of scientific inquiry, such as the investigation of the preparation of fish by methods of dehydration and the study of methods of preventing the deleterious reddening of salt codfish. In some instances the situation seemed to demand not investigation, but action, and in such cases the scientific personnel of the Bureau was ready and effective for the performance of any service that the situation seemed to require. Consequently, it is proper in connection with the report of scientific investigations to mention the cooperative services rendered in the campaign for increased consumption of fish from the Gulf of Mexico involving efforts to facilitate capture, transportation, and sale of the fish; the giving of demonstrations and personal instruction in the proper cure of Alaska herring; the partial equipment of an experimental fishery-products laboratory in southern California; and the conduct of experiments in the preservation of fish by methods of canning, salting, and smoking.

While legislation for the protection of fish and shellfish is a function of the several States, it is one of the primary objects of the scientific activities of the Bureau of Fisheries to acquire and distribute such information as will be useful in the framing and enforcement of wise protective laws. Allusion has already been made to assistance afforded the authorities of several States with regard to the protection of the salmon, the blue crab, and the spiny lobster. Cooperation of like nature has been extended in relation to various other fishery resources, notably the fresh-water mussels.

It has been evident for a number of years that the future of the fresh-water mussel industries was largely dependent upon the adoption of proper measures of conservation. An important step in the direction of conservation was taken when, following a series of investigations by the Bureau of Fisheries, Congress authorized the conduct of the artificial propagation of mussels in connection with the establishment of the fisheries biological station at Fairport. The success of artificial propagation, however, is dependent upon the adoption and enforcement of appropriate protective measures, and for this phase of conservation the States alone are responsible. It is not only important that the several States concerned should enforce measures of protection, but, since the mussel resources are frequently found in interstate streams, it is an essential condition of the best results that there should be identical or concurrent legislation among the several States exercising jurisdiction over the different portions of a stream.

Much interest in the matter of concurrent legislation has been manifested not only by the manufacturers of pearl buttons and the mussel fishermen, but by responsible officials of several States as well. The Bureau of Fisheries has also endeavored to cooperate with all interested persons in the devising of protective measures which would be effective in the accomplishment of the desired results without creating greater disturbance of economic conditions than is inevitable. Having been informed that serious efforts were being made in several States of the Mississippi Basin to have protective legislation enacted by the legislatures then in session, the Bureau prepared a statement treating of the necessity for measures of conservation, and this statement was comprised in a paper entitled "Fresh-Water Mussels: A Valuable National Resource Without Sufficient Protection," issued in February and widely distributed in the States concerned.

It seems not inappropriate to direct attention to the fact that the scientific activities of the Bureau have suffered in consequence of the wide disparity between the salaries paid in the Bureau and those paid for work of similar character in other branches of the Government service, and more especially in outside institutions of learning or research. In consequence of this condition, it is found impossible to keep the lower positions continuously filled, and the effective personnel is always less than the nominal personnel as authorized by the Congress. That a gratifying degree of progress in investigational work has been made during the fiscal year under report is due in great measure to the labors of loyal and self-sacrificing assistants who have devoted themselves permanently or temporarily to national service through the Bureau of Fisheries. It is only fair to them that this statement should be made.

## BIOLOGICAL LABORATORIES.

Owing to exceptional conditions none of the Bureau's biological laboratories were in regular and full operation during the fiscal year 1919.

The laboratory at Beaufort, N. C., had been surrendered to the Navy Department for the period of the war, the Bureau having entirely withdrawn except as the experiments in terrapin culture were continued in such manner as to prevent the loss of valuable stock or the interruption of experiments which involved observations and records during periods of several years. At the close of the fiscal year negotiations between the Department of Commerce and the Navy Department were in progress looking to the return of the station to this Bureau.

The Woods Hole (Mass.) laboratory was largely occupied by the Navy Department, and the Bureau had either abandoned temporarily or transferred to other points the investigations normally conducted at this station.

The Fairport (Iowa) biological station was in fuller operation than any other, but since it had been impossible to replace immediately the main building destroyed by fire in December, 1917, the station was operated during the summer of 1918 with a reduced force. Nevertheless, through the loyal cooperation of the permanent personnel of the station and the cheerful submission by temporary investigators to service under conditions of discomfort and inadequate facilities, the progress of the work of the station suffered much less interruption than might have been expected. Some important phases of the work of this station have already been alluded to in connection with various special subjects.

In the early part of the fiscal year advertisements were made soliciting bids for the construction of a fireproof building at Fairport, as authorized by Congress with the appropriation of $80,000 for its construction and equipment. Notwithstanding that the Bureau had made a special effort to reduce the cost of the building as much as possible without sacrificing the essentials of safety and efficiency, the lowest bid received was found to be beyond the available appropriation. Steps were taken immediately to revise the plans, partly by the elimination of some desirable facilities and partly by the most careful attention to such details of construction as might permit a reduction in costs without sacrifice of value. Bids were again solicited during the spring of 1919, but again none was received that came within the amount of the appropriation. It was, therefore, deemed unavoidable that a supplemental estimate be submitted to the Congress. This having been done, an additional appropriation of

$10,000 was made available, and the work of construction is in progress.

At the Key West (Fla.) biological station further progress in construction has been made, and the station is rendering a useful, if as yet somewhat limited, service. The inadequacy of the appropriations granted for the construction and equipment of this laboratory, as well as for its personnel, are matters which will be presented to the Congress in connection with the estimates for the fiscal year 1921. The activities of the station at present have to do with the spiny lobster, with results as indicated on a preceding page, and with the habits, distribution, and propagation of marine fishes.

The Bureau maintains no biological laboratory on the west coast, although it enjoys at times the courtesies of other laboratories existing on that coast. It has also several assistants engaged actively in investigations localized in Pacific Coast States. Since a local headquarters has been found desirable in addition to the office maintained at Seattle, the Bureau has reopened an office in San Francisco. With one resident officer in charge, this office serves a very useful purpose, not only as a headquarters and base of supplies for investigators and other employees, but as an agency for the transaction of local business of the Bureau and for the dissemination of information to the public. Appreciation of the service of this office is attested by the increasing number of persons who call to consult the Bureau's publications, to secure its economic circulars and memoranda, or to solicit information on diverse subjects relating to fish and fisheries.

## PROPAGATION AND DISTRIBUTION OF FOOD FISHES.

### RÉSUMÉ OF THE OPERATIONS.

The artificial propagation and distribution of food fishes, together with the various collateral activities closely associated therewith, were attended by serious drawbacks in 1919. Difficulty in obtaining and retaining the services of qualified men at the compensation allowed by Congress; the increasing cost of labor, materials, and supplies; and increased charges for the movement of fish-distributing cars, amounting to more than 50 per cent since January 1, 1919, were among the circumstances that combined to retard operations and that compelled most careful planning, efficient execution, and sustained interest and zeal in order to maintain the magnitude and quality of the work without exceeding the funds available.

Nevertheless, the year's output of food and game fishes was larger than ever before. The total number of fishes and fish eggs distributed was about 5,876,985,000, an increase of 718,000,000 over 1917 and about 1,778,000,000 over 1918. Nearly 733,000,000 of fertilized eggs were sent out from the Federal hatcheries; most of these were from the commercial species of the Great Lakes and from Pacific salmons and nearly all were consigned to State hatcheries, where incubation was completed, the young being planted in local waters. Upward of 440,000,000 eggs of marine fishes were obtained from commercial fishermen of New England, fertilized and planted on the spawning grounds, in addition to the large numbers handled at the hatcheries. Over 4,500,000,000 of young fish were distributed as fry, mostly lake trout, whitefish, cisco, and pike perch on the Great Lakes; shad, salmon, yellow perch, and striped bass on the coastal rivers; carp and buffalofish in the interior waters; and cod, haddock, pollock, and flounder on the Atlantic seaboard. The output of fingerlings, yearlings, and adults was upward of 151,000,000, with catfish, carp, chinook salmon, sockeye salmon, brook trout, rainbow trout, and crappies predominating. Although the distribution of fish in the fingerling stage decreased about 10 per cent from 1918, this falling off was practically confined to one species and indicates no slackening of effort. On the contrary, facilities for fingerling production are being increased, particularly as regards the salmons of the Pacific coast.

Comparing the general distribution of 1919 and 1918, it may be noted that there was an increase in cisco, rainbow trout, Atlantic salmon, landlocked salmon, buffalofish, carp, shad, pike perch, yellow perch, crappies, pollock, and haddock, and there was a decrease in whitefish, chinook salmon, steelhead salmon, and lake trout.

SUMMARY BY SPECIES, OF THE DISTRIBUTION OF FISH AND FISH EGGS DURING THE FISCAL YEAR 1919.

| Species. | Eggs. | Fry. | Adults, yearlings, and fingerlings. | Total. |
|---|---|---|---|---|
| Catfish | | | 12,639,830 | 12,639,830 |
| Carp | | 23,699,000 | 19,754,060 | 43,453,060 |
| Buffalofish | | 111,100,000 | 2,596,335 | 113,696,335 |
| Shad | | 84,024,250 | | 84,024,250 |
| Alewife | | 25,000 | | 25,000 |
| Whitefish | 111,650,000 | 198,715,000 | | 310,365,000 |
| Lake herring (cisco) | 146,700,000 | 86,180,000 | | 232,880,000 |
| Chinook salmon | 11,802,500 | 1,016,600 | 34,400,150 | 47,219,250 |
| Sockeye salmon | 24,140,100 | 39,756,000 | 37,642,220 | 101,538,320 |
| Silver salmon | | 7,464,020 | 2,345,730 | 9,809,750 |
| Humpback salmon | | 5,426,500 | 369,960 | 5,796,460 |
| Chum salmon | | 6,253,640 | 3,663,760 | 9,917,400 |
| Atlantic salmon | | 2,390,000 | 700 | 2,390,700 |
| Landlocked salmon | 405,125 | 424,870 | 182,560 | 1,012,555 |
| Steelhead salmon | 805,000 | 128,125 | 1,493,290 | 2,426,415 |
| Rainbow trout | 2,939,820 | 38,500 | 3,409,190 | 6,387,510 |
| Blackspotted trout | 133,000 | 200,000 | 2,875,100 | 3,208,100 |
| Lock Leven trout | | | 73,000 | 73,000 |
| Lake trout | 3,068,000 | 28,495,475 | 765,180 | 32,328,655 |
| Brook trout | 107,000 | 4,158,050 | 7,638,615 | 11,903,665 |
| Grayling | | 275,000 | | 275,000 |
| Smelt | 3,000,000 | 6,437,000 | | 9,437,000 |
| Pike and pickerel | | | 375,985 | 375,985 |
| Freshwater drum | | | 18,975 | 18,975 |
| Crappies | | | 15,837,865 | 15,837,865 |
| Largemouth black bass | | 425,045 | 1,100,420 | 1,525,465 |
| Smallmouth black bass | | 195,700 | 43,745 | 239,445 |
| Rock bass | | | 75,460 | 75,460 |
| Warmouth bass | | | 1,060 | 1,060 |
| Sunfish | | 3,050 | 1,350,115 | 1,353,165 |
| Pike perch | 406,200,000 | 175,550,000 | 10,710 | 581,760,710 |
| Yellow perch | 22,660,000 | 179,289,500 | 2,353,800 | 204,303,300 |
| White perch | | 2,035,000 | | 2,035,000 |
| White bass | | | 8,865 | 8,865 |
| Yellow bass | | | 600 | 600 |
| Striped bass | | 13,540,000 | | 13,540,000 |
| Mackerel | | 9,508,000 | | 9,508,000 |
| Cod | 243,870,000 | 64,331,000 | | 308,201,000 |
| Pollock | | 703,972,000 | | 703,972,000 |
| Haddock | 200,390,000 | 129,592,000 | | 329,982,000 |
| Winter flounder | | 2,654,192,000 | | 2,654,192,000 |
| Miscellaneous fishes | | 1,000,000 | 747,250 | 1,747,250 |
| Lobster | | 7,500,000 | | 7,500,000 |
| Total | 1,177,870,545 | 4,547,340,325 | 151,774,480 | 5,876,985,350 |

## HATCHERIES OPERATED.

There has been no addition to the list of regular hatcheries operated. A hatchery provided by the National Park Service of the Department of the Interior was constructed under the supervision of the Bureau in Glacier National Park and is being maintained as an auxiliary of the Bozeman (Mont.) station. Its special function is to maintain and increase the supplies of fish in the various waters of the park. The construction of the hatchery in Rhode Island has been further delayed by the inadequacy of the available appropriation, and Congress will have to provide a substantial addition to the original sum in order that the hatchery and other necessary structures may be completed. The shad hatchery in Maryland, near the mouth of the Susquehanna River, whose operations were suspended by order of the Secretary because of failure of the State to conform with the requirements imposed by Congress, has remained closed, and its equipment has been largely transferred to other stations.

The hatchery work as carried on at the 70 main and auxiliary stations in 1919 was located in 33 States and Alaska. The following list, arranged in alphabetical order by States, shows the fish-cultural stations and auxiliaries in operation during 1919, with the fishes handled at each. Mere egg-collecting stations are not included.

MAIN AND AUXILIARY FISH-CULTURAL STATIONS OPERATED DURING THE FISCAL YEAR, 1919.

| State and locality. | Species handled. |
|---|---|
| Alaska: | |
| Afognak | Sockeye and humpback salmons. |
| Yes Bay | Do. |
| Arkansas: Mammoth Spring | Largemouth and smallmouth black basses. |
| California: | |
| Baird | Chinook salmon. |
| Battle Creek | Do. |
| Mill Creek | Do. |
| Colorado: Leadville | Blackspotted, brook, lake, and rainbow trouts. |
| Georgia: Cold Springs | Bass, sunfish, catfish. |
| Idaho: Paris[a] | Whitefish. |
| Illinois: | |
| Meredosia | Rescued fishes. |
| Quincy | Do. |
| Iowa: | |
| Fairport | Do. |
| Manchester | Brook and rainbow trouts, bass, sunfish. |
| Bellevue | Rescued fishes. |
| North McGregor | Do. |
| Kentucky: Louisville | Brook and rainbow trouts, bass, sunfish. |
| Louisiana: Atchafalaya | Buffalofish. |
| Maine: | |
| Boothbay Harbor | Cod, haddock, flounder. |
| Craig Brook | Atlantic and landlock salmons, brook trout. |
| Green Lake | Landlocked and steelhead salmons, brook trout, smelt. |
| Grand Lake Stream | Landlocked salmon. |
| Maryland: Bryans Point | Shad, yellow perch. |
| Massachusetts: | |
| Berkshire | Brook and rainbow trouts, smallmouth black bass. |
| Gloucester | Cod, haddock, pollock, flounder. |
| Woods Hole | Cod, flounder. |
| Michigan: | |
| Northville | Brook and rainbow trouts, smallmouth black bass. |
| Alpena | Lake trout, whitefish. |
| Bay City | Pike perch. |
| Charlevoix | Lake trout, steelhead salmon, whitefish, pike perch. |
| Detroit | Pike perch. |
| Minnesota: | |
| Duluth | Brook and lake trouts, whitefish, pike perch. |
| Homer | Black bass, rock bass, rescued fishes. |
| Mississippi: | |
| Tupelo | Black bass, crappie, sunfish, warmouth bass. |
| Friars Point | Rescued fishes. |
| Missouri: Neosho | Catfish, rainbow trout, black bass, crappie, sunfish. |

[a] Auxiliary of the Springville (Utah) hatchery.

MAIN AND AUXILIARY FISH-CULTURAL STATIONS OPERATED DURING THE FISCAL YEAR 1919—Continued.

| State and locality. | Species handled. |
|---|---|
| Montana: | |
| Bozeman | Blackspotted, brook, and rainbow trouts, grayling. |
| Glacier National Park | Blackspotted, brook, and rainbow trouts. |
| New Hampshire: Nashua | Brook and rainbow trouts, landlocked salmon, smallmouth black bass. |
| New York: Cape Vincent | Brook and lake trouts, whitefish, cisco, yellow perch. |
| North Carolina: | |
| Edenton | Shad, black bass, sunfish, yellow perch, white perch. |
| Weldon | Striped bass. |
| Ohio: Put in Bay | Carp, whitefish, pike perch, yellow perch. |
| Oregon: | |
| Clackamas | Chinook and steelhead salmons, blackspotted, brook, and rainbow trouts. |
| Applegate | Chinook, silver, and steelhead salmons. |
| Rogue River | Chinook, silver, and steelhead salmons, blackspotted and rainbow trouts. |
| Upper Clackamas | Chinook, silver, and steelhead salmons. |
| Willamette Falls | Shad. |
| St. Helens | Do. |
| South Carolina: Orangeburg | Catfish, black bass, sunfish. |
| South Dakota: Spearfish | Blackspotted, brook, lake, and Loch Leven trouts, steelhead salmon. |
| Tennessee: Erwin | Brook and rainbow trouts, black bass, sunfish. |
| Texas: San Marcos | Black bass, sunfish. |
| Utah: Springville | Blackspotted, brook, and rainbow trouts. |
| Vermont: | |
| St. Johnsbury | Brook, lake, and rainbow trouts, landlocked and steelhead salmons, smallmouth black bass. |
| Holden | Brook and lake trouts, landlocked and steelhead salmons. |
| Swanton | Pike perch, yellow perch. |
| Virginia: Wytheville | Brook and rainbow trouts, black bass, sunfish. |
| Washington: | |
| Baker Lake | Chinook and sockeye salmons. |
| Birdsview | Chinook, chum, humpback, silver, sockeye, and steelhead salmons, blackspotted trout. |
| Darrington | Chum and silver salmons. |
| Brinnon | Chum, silver, and steelhead salmons. |
| Sultan | Chinook, silver, and steelhead salmons. |
| Quinault | Chinook, silver, and sockeye salmons. |
| Duckabush | Chum, humpback and silver salmons. |
| Quilcene | Chinook, chum, humpback, silver, and steelhead salmons. |
| Big White Salmon [a] | Chinook salmon. |
| Little White Salmon [a] | Chinook, chum, and sockeye salmons. |
| West Virginia: White Sulphur Springs | Brook and rainbow trouts, black bass, sunfish. |
| Wisconsin: La Crosse | Brook and rainbow trouts, rescued fishes. |
| Wyoming: | |
| Saratoga | Blackspotted, brook, and rainbow trouts, steelhead salmon. |
| Yellowstone National Park [b] | Blackspotted trout. |

[a] Auxiliary of the Clackamas (Oreg.) hatchery.

[b] Auxiliary of the Bozeman (Mont.) hatchery.

Five special railway cars employed in distributing the output of the hatcheries traveled 97,571 miles, and detached messengers in charge of special shipments of fish traveled 425,966 miles. Distributions were made, as usual, in every State and Alaska.

The United States Railroad Administration adopted a new tariff for the movement of fish cars, which went into effect January 1, 1919. The charge for a one-way movement of a car is 10 one-way adult fares, with a minimum charge of $15. This is a material increase over the average rate formerly paid by the Bureau. The United States Railroad Administration also adopted new regulations governing the transportation of live fish in cans and fish eggs in crates in regular baggage service. Effective May 1 in southeastern territory, June 15 in eastern territory, and April 1 in western territory, the baggage tariff was changed to provide for handling not to exceed twenty 10-gallon cans of live fish or 20 crates of fish eggs, or 20 such containers combined.

During the year there were received 8,603 applications for fish for interior waters, most of the applications bearing the indorsement of a Senator or Representative in Congress. It has been possible to take favorable action on practically all of these applications, the only exception being in the case of the smallmouth black bass, the demand for which is far in excess of the output of the few hatcheries at which this species can be successfully produced.

## RELATIONS WITH THE STATES IN FISH CULTURE.

Practical cooperation with the States has continued to prevail throughout the country. In several States egg-collecting stations have been operated jointly, the eggs taken being developed in the hatcheries most conveniently located or from which distribution of the resulting fry could be most advantageously accomplished.

Large numbers of eggs and limited numbers of young fish have been donated to the State fish commissions. This cooperation was extended to 29 States and covered upward of 670,000,000 eggs and over a million young fish, as shown in the following table. On the other hand, various States have made similar donations to the Bureau.

### ALLOTMENT OF FISH AND FISH EGGS TO STATE FISH COMMISSIONS DURING THE FISCAL YEAR 1919.

[All figures are for eggs unless otherwise indicated. Fingerlings are designated *a* and fry *b*.]

| State and species. | Number. |
|---|---|
| California: Chinook salmon | 11,802,500 |
| Connecticut: | |
| Catfish | *a* 1,100 |
| Crappie | *a* 3,600 |
| Sunfish | *a* 1,400 |
| Yellow perch | *a* 1,625 |
| Idaho: Rainbow trout | 50,000 |
| Illinois: Whitefish | 5,000,000 |
| Indiana: Pike perch | 8,050,000 |
| Iowa: | |
| Rainbow trout | 70,000 |
| Rock bass | *a* 13,000 |
| Pike perch | 5,000,000 |
| Kentucky: | |
| Brook trout | *a* 150 |
| Rainbow trout | *a* 4,250 |
| Yellow perch | *b* 100,000 |
| Maine: Landlocked salmon | 405,127 |
| Maryland: | |
| Rainbow trout | 50,000 |
| Rock bass | *a* 2,900 |
| Sunfish | *a* 1,415 |
| Sucker | *b* 1,000,000 |
| Massachusetts: Pike perch | 5,100,000 |
| Michigan: | |
| Lake trout | 1,000,000 |
| Whitefish | 20,000,000 |
| Pike perch | 288,800,000 |
| Minnesota: | |
| Lake trout | 250,000 |
| Rainbow trout | 50,000 |
| Steelhead salmon | 125,000 |
| Black bass | *a* 6,500 |
| Missouri: Yellow perch | 160,000<br>*b* 40,000 |
| Montana: | |
| Catfish | *a* 2,400 |
| Brook trout | *a* 3,000 |
| Rainbow trout | 1,000,000 |
| Black bass | *a* 700 |
| Crappie | *a* 1,300 |
| Yellow perch | *a* 780 |
| Nevada: Rainbow trout | 25,000 |
| New Hampshire: | |
| Rainbow trout | *a* 2,224 |
| Pike perch | 6,000,000 |
| New Jersey: | |
| Rainbow trout | 35,000 |
| New Jersey—Continued. | |
| Steelhead salmon | 25,000 |
| Yellow perch | 21,500,000 |
| New York: | |
| Lake trout | 1,800,000 |
| Whitefish | 9,000,000 |
| Lake herring | 32,500,000 |
| Landlocked salmon | *b* 15,000 |
| Steelhead salmon | 200,000 |
| Strawberry bass | *a* 100 |
| Sunfish | *a* 100 |
| Pike perch | 60,000,000 |
| Ohio: Whitefish | 10,800,000 |
| Oklahoma: | |
| Rainbow trout | *a* 7,800 |
| Black bass, largemouth | *a* 3,600 |
| Black bass, smallmouth | *a* 400 |
| Oregon: | |
| Blackspotted trout | 121,000 |
| Rainbow trout | 765,000 |
| Sockeye salmon | 3,440,100 |
| Pennsylvania: | |
| Whitefish | 37,070,000 |
| Lake herring | 88,700,000 |
| Pike perch | 15,050,000 |
| Rhode Island: | |
| Black bass, smallmouth | *b* 7,500 |
| Pike perch | *b* 200,000 |
| South Dakota: | |
| Brook trout | *a* 45,000 |
| Rainbow trout | *a* 50,000 |
| Tennessee: Rainbow trout | 42,700 |
| Vermont: | |
| Steelhead salmon | 50,000 |
| Pike perch | 16,200,000 |
| Washington: | |
| Rainbow trout | 100,000 |
| Steelhead salmon | 230,000 |
| Wisconsin: | |
| Catfish | *a* 7,200 |
| Whitefish | 20,000,000 |
| Black bass | *a* 5,000 |
| Wyoming: | |
| Rainbow trout | 100,000 |
| Steelhead salmon | 50,000 |
| Total | 670,716,427<br>*a* 165,544<br>*b* 1,362,500 |

## PROPAGATION OF COMMERCIAL FISHES OF GREAT LAKES.

While there were many discouraging features connected with the propagation of the commercial fishes of the Great Lakes, the aggregate output of the hatcheries was nearly twice as large as in 1918. Unfavorable weather during the spawning season, together with the scarcity of skilled labor, tended to reduce the numbers of lake trout and whitefish produced, but the poor showing in that branch of the work was in part compensated for by the large increase in the output of cisco and pike perch, the production of which was six times greater than in the preceding year.

For the first time in its history, the Duluth hatchery was stocked with pike-perch eggs collected in State waters, this being made possible through an arrangement with the State authorities for cooperative work at Pike River. The Bureau's share of the operations was 40,000,000 eggs.

A temporary hatchery established at Bay City, Mich., on Saginaw Bay, was equipped with apparatus from other Michigan stations and supplied with water from the city mains for the purpose of utilizing the large number of pike-perch eggs which were reported to be obtainable from the commercial fishermen of that region. The fishermen cooperated to the fullest possible extent in supplying eggs, and the success of the collections far exceeded all expectations. Consignments of eggs from this station were as follows: Two hundred and eighty-eight million eight hundred thousand to the Detroit State hatchery; 60,000,000 to the New York Conservation Commission, and 29,250,000 to the auxiliary hatchery of the Bureau at Charlevoix. The 95,400,000 eggs which were retained at Bay City were lost owing, it is supposed, to chlorine used by the city authorities for clarifying and purifying the water. It is evident that favorable work in pike-perch propagation may be done at this point, and the establishment of a hatchery with a capacity of at least 1,000 jars is desirable. This plant could handle other fish besides pike perch, and there is particular need for artificial propagation addressed to local ciscoes or lake herrings.

In the Lake Michigan and Lake Huron fields covered by the auxiliaries of the Northville station, it was necessary, owing to lack of men, to reduce the number of egg-collecting points formerly operated, which condition, combined with abnormally warm weather and a small run of fish, resulted in the taking of only 33,269,000 lake-trout eggs, less than half the previous year's record. Whitefish eggs for the substation at Charlevoix to the number of 35,548,000 were secured from Lakes Michigan and Huron and were supplemented by shipments of 64,680,000 eggs from Lake Erie, all of poor quality. In the whitefish operations of the Put in Bay hatchery in Lake Erie, 420,650,000 eggs were collected, all but 50,000,000 being obtained from fish taken by commercial fishermen. A considerable proportion of these eggs were consigned to the various State fish commissions, and upward of 126,000,000 vigorous fry were liberated from the Put in Bay hatchery.

The Cape Vincent hatchery had an unusually successful season. For the first time since its establishment, no lake-trout eggs were shipped from other stations, full reliance being placed on home collections. Whitefish eggs to the number of 93,510,000 were secured from fishermen of Lake Ontario, the great bulk of this take coming from the Canadian side of the lake under an arrangement with the fishery authorities of Canada. The hatchery was overstocked, and consignments of eggs were made to New York, Pennsylvania, and Canadian hatcheries. Fisheries at Fair Haven and Sodus Point yielded 218,000,000 eggs of the cisco, and fisheries in the eastern end of the lake produced additional eggs that brought the total to 239,950,000, of which 146,700,000 were transferred to hatcheries in New York, Pennsylvania, and Canada. The immediate output of the Cape Vincent station was 86,180,000 cisco fry, all planted in Lake Ontario.

In the usual operations on Lake Champlain addressed to the pike perch, 245,350,000 eggs were taken at the newly acquired site near the mouth of Swanton River, and after considerable numbers were shipped to applicants the remainder were incubated at Swanton, yielding 71,500,000 fry which were deposited locally.

An attempt is being made to establish a run of chinook salmon in the St. Lawrence River and Lake Ontario, and to this end chinook salmon eggs in limited number are being sent from the Pacific coast to the Cape Vincent hatchery. The first shipment, consisting of 820,000 eyed eggs from the Little White Salmon hatchery on the Columbia River arrived at Cape Vincent in November, 1918, and 798,400 fry were hatched therefrom. Some of the young reared in troughs took food readily and made splendid growth and had small mortality. The result of this shipment was the planting of 627,000 advanced fry and 150,000 fingerlings.

Mention should be made of the inauguration of whitefish hatching at Bear Lake, situated in Idaho and Utah. A field station, auxiliary to the Springville hatchery, was established at Paris, Idaho, in the autumn of 1918, and several million eggs were secured from fish taken by net fishermen. The experience gained will be valuable in planning for the continuance of this work, which is demanded in order to perpetuate and maintain the whitefish peculiar to this lake.

### CULTIVATION OF POND AND RIVER FISHES.

The numerous stations throughout the country that are concerned with the maintenance of the supplies of fish in the rivers and minor waters of the interior have in general been successful in meeting the ever-increasing demands that have been made on them for trouts, basses, and other species.

The demand for brook trout far exceeds the productive capacity of the hatcheries when reliance is placed solely on the eggs obtainable from brood fish and from wild fish in waters available to the various hatcheries. It has, therefore, been necessary to supplement the local collections by considerable numbers of eggs purchased from commercial fish-culturists. During the year 1919 approximately 11,000,000 such eggs were distributed among 15 stations. The other brook-trout eggs that were handled in 1919 consisted of 900,000 collected from wild fish in Vermont, 4,350,000 from wild fish in Colorado, Utah, and Wyoming, and smaller numbers from domesticated fish, the total number from all sources being 16,463,200. The output of 11,903,665 included 7,638,615 distributed as fingerlings. All pending applications for brook trout have been filled by liberal allotments, and carload shipments have in addition been made to various national forests, the deliveries being to officers of the Forest Service who superintended the planting of the fish.

The demand for rainbow trout is next to that for the brook trout. Considerable collections of eggs have, as usual, been made from domesticated fish held in ponds at the Wytheville, Erwin, White Sulphur Springs, Manchester, and Neosho stations, but the bulk of the eggs—namely, 7,357,100—has come from wild fish in Montana, Wyoming, and Utah. A new and very promising field for collecting eggs of wild rainbow trout has been located in Sage Creek, Wyo., about 70 miles from the Saratoga station. The Madison Valley field in Montana, operated from the Bozeman station, was unusually productive, and 3,935,000 eggs of exceptionally good quality were secured, an increase of nearly a million over the record season of 1918. The collection of grayling eggs in this same locality was the smallest for a number of years.

The landlocked salmon is in great demand in its native State of Maine and in various States to which it is not indigenous. The sources of egg supply in 1919 were Green Lake, Fish River Lakes, and Grand Lake Stream, the number of eggs obtained being 213, 000, 914, 000, and 345,000, respectively. The first duty of the Bureau as regards landlocked salmon is to maintain the fish in its home waters. As these waters are extensive and many of them are depleted, and as the number of fish available for distribution is limited, many applications from outside States have had to be refused.

The available supply of basses, crappies, sunfishes, etc., has been about the average of recent years. The Mammoth Spring station, the principal source of smallmouth black bass, suffered a serious reduction in output owing to the loss of brood fish by flood. The extension of facilities for black-bass culture is constantly in progress, but the demand can not be adequately met with the existing stations, and an increase in bass stations is needed, particularly in the southwestern section of the country.

In the second season's operations at the temporary field hatchery on the Atchafalaya River in Louisiana, the output of buffalofish was materially increased. From fish caught for market the Bureau's agents, in cooperation with the State department of conservation, were able to save 136,200,000 eggs, from which 110,940,000 fry were hatched. Extremely unfavorable weather interfered with the work and reduced the output.

## CARP CULTURE.

Carp culture, discontinued many years ago, has been resumed, as yet on an experimental scale, on Lake Erie in response to a strong local demand from carp fishermen and carp dealers. The western end of the lake is the scene of extensive carp fishing, in connection with which there are maintained large inclosures in which carp are held alive pending shipment to market. The Bureau's operations consist in taking eggs from the fish caught in seines in the Portage River, Ohio, which would otherwise be lost, and hatching them at the Put-in Bay station, the fry being returned to the local waters in which the carp spawn naturally. During the fiscal year 1919 the young carp thus produced and liberated numbered 22,800,000.

Widespread interest in the carp among landowners is evidenced by the large number of applications submitted from all parts of the country for carp for stocking private ponds. In view of the unsuitability of the carp for many waters and the prejudice against it that exists partly because of the mistakes made in the original plantings, the Bureau refers all applications to the fishery authorities of the respective States and defers to their recommendation in acting on applications. Without the State's indorsement the requests for carp are denied.

## PROPAGATION OF RIVER FISHES OF ATLANTIC SEABOARD.

Fairly successful results attended the work of the shad hatcheries on the Potomac River and Albemarle Sound, the fry planted numbering 68,558,550, as compared with 39,168,800 in 1918. Most of this output is to be credited to the Bryans Point hatchery, but the Edenton hatchery had a noteworthy increase over all recent years.

The striped-bass hatchery maintained on the Roanoke River as an auxiliary of the Edenton station experienced drawbacks owing to flood water. During the very short spawning season (Apr. 29 to May 11) 17,942,000 eggs were collected; the fry hatched therefrom, numbering 13,540,000, were deposited locally.

In the artificial propagation of the Atlantic salmon, designed primarily to perpetuate the run of that species in the Penobscot River, 870 adult fish were collected in spring and held in pens, and from the 700 survivors at the spawning time 2,613,400 eggs were obtained, the brood fish then being released. The eggs were hatched in 165 days at a mean temperature of 38° F., and the young, numbering 2,390,000, were deposited at suitable points in the Penobscot, Dennys, Pleasant, and Narraguagus Rivers.

At the Bryans Point hatchery the usual excellent results were secured in the propagation of yellow perch. Adult fish that had been caught for market were obtained from fishermen and held in live cars until their eggs were deposited. The fry from this source, all planted in the Potomac and tributaries, numbered 153,679,500.

## PACIFIC SALMON OPERATIONS.

Throughout the Pacific States and Alaska the Bureau's salmon-cultural operations in the season 1918–19 were hampered by war activities and by the high cost of materials and the high cost and scarcity of labor. No improvements or repairs at the stations other than those of a minor and pressing character were attempted, and those were done mostly by the regular station force. The untoward conditions were aggravated by the impossibility of maintaining a complete personnel in the statutory positions; at times in certain fields more than 50 per cent of the regular positions were unfilled. A further drawback was the influenza epidemic.

Satisfactory operations were conducted at the two Alaska stations, the collection of eggs of the sockeye salmon at the Afognak hatchery being the largest since the eruption of Mount Katmai in 1912, when all the sockeye salmon inhabiting lakes and streams in the ash belt were destroyed. The take of eggs in these waters has been gradually increasing since 1914, when 7,380,000 were obtained, rising to 54,681,-

000 in 1918, with indications of a still greater improvement during the 1919 season. At the Yes Bay hatchery 47,300,000 sockeye salmon eggs were secured, as against 34,950,000 in the previous season. An innovation in the holding and rearing of young salmon has been inaugurated at Yes Bay by the treatment of the hatchery creek. The water passing through the creek is controlled by a 6-foot gauge, and a 1,000-foot space at the upper end is divided into numerous feeding ponds by placing semicircular rock dams across the stream, while a wire trap has been placed at the lower end of the creek for the capture of Dolly Varden and cutthroat trout, natural enemies of the young salmon in this region. At the lower end of the lake an area of about 4 acres has been screened off and about 6,000,000 young salmon have been placed therein for rearing.

At the various hatcheries in Washington the salmon of all species liberated have aggregated 38,378,285, of which 21,103,025 were fingerlings, while 1,791,000 additional fingerlings were on hand at the end of the fiscal year. At Birdsview, the principal station in the vicinity of Puget Sound, the collections were less extensive than in the previous year, but at Baker Lake the season's outcome was, on the whole, an improvement over several previous years. In continuance of the efforts to establish a run of humpback salmon in the off years, consignments of eggs have been sent from the Alaska stations, and the resulting young have been planted in various tributaries of Puget Sound.

In the Columbia River and throughout the Oregon fields the work at all salmon stations was seriously handicapped by long-continued drought and by the activities of the commercial fishermen, which resulted in the escapement of only a limited number of fish to the spawning grounds. At the Little White Salmon station 10,693,000 chinook-salmon eggs were obtained, and from these 9,177,500 No. 2½ fingerlings were produced. At the Big White Salmon station the egg collections were relatively large, aggregating 10,665,000 the young from which were planted locally as No. 2½ fingerlings.

Salmon hatching in California, at Baird and subsidiary stations, was less extensive than in previous years, owing to low stages of the Sacramento River resulting from a drought. The success of the salmon work in this field is imperiled by the irrigation dam at Redding. No fish are able to pass over this dam excepting, possibly, a few of the early run, which may get over before the slide boards are put in place. No fishway is available, and people living in the vicinity are continually using spears and hooks in the capture of the spawning fish congregated below the dam. The State authorities have promised to install fish ladders, but even with that advantage the future operations are doomed if fishermen are allowed to continue their operations. At the Mill Creek station 17,284,500 chinook-salmon eggs were collected, of which 11,164,500 were shipped when eyed to the State hatchery at Sisson, and 2,304,000 were transferred to Baird. The remaining eggs produced 3,498,800 fingerlings of Nos. 1½ and 2 sizes, all of which were planted in the creek. At Battle Creek, formerly one of the most productive salmon stations on the Pacific coast, only 5,384,000 eggs were obtained. Of these, 638,000 were shipped to the Sisson hatchery, and from the remainder 4,509,000 fry were hatched and reared to the fingerling stage before liberation. No spawn-taking operations were conducted at the Baird hatchery, and there was no noticeable run of salmon in the McCloud River. The work at this pioneer salmon hatchery was reduced to the care of the eggs shipped from its Mill Creek auxiliary. The output, consisting of 2,280,000 Nos. 1½ and 2 fingerlings, was planted in the McCloud River.

The season of 1918 was one of the most successful for shad production on the Pacific coast. Two field hatcheries operated at Willamette Falls and St. Helens, Oreg., as auxiliaries of the Clackamas station, collected 17,265,000 shad eggs from the fishermen's catch.

### CULTIVATION OF MARINE SPECIES.

Marine-fish culture, conducted at the three New England stations—Boothbay Harbor, Me.; Gloucester, Mass.; and Woods Hole, Mass.—was as a whole successful.

Perhaps the most effective branch of this work is that addressed to the winter flounder (Pseudopleuronectes), a species that within a few years has assumed great commercial value in Massachusetts and is now rapidly growing in importance in Maine, giving employment to many persons and yielding good returns at a time when there is little else for the fishermen to do. At Boothbay Harbor egg collections from local waters, especially Linekins Bay, aggregated 1,326,408,000, from which 1,279,256,000 fry were hatched and planted, a very high percentage. At Gloucester, where the catch of gravid flounders was below the average for the past three years, 152,020,000 eggs were taken, and 138,990,000 fry were obtained therefrom, the percentage of hatch being about 91.5. The flounder work at Woods Hole was the most extensive in the history of the station. Most of the eggs, aggregating 1,433,613,000, were obtained from Waquoit Bay fish, but other points on Vineyard Sound and Buzzards Bay yielded considerable numbers, while at a field station established at Wickford, R. I., on Narragansett Bay, 323,238,000 eggs were secured and sent to Woods Hole for incubation. The output was 1,098,130,000 fry and 137,816,000 eyed eggs which latter had to be planted because of the crowded condition of the hatchery.

The hatching of eggs of the shore cod was on such a small scale as to be practically a failure at all stations. There was a fairly large collection of eggs for the Gloucester hatchery, but the low density of the water produced a heavy mortality among the eggs undergoing incubation and made undesirable the sending of other eggs which, to the number of several hundred million, were in consequence deposited on the spawning grounds.

A force of spawn takers working among the Gloucester haddock and pollock fishermen took large numbers of eggs from fish that had been caught for market. Upward of 1,110,470,000 pollock eggs were collected and 702,250,000 fry were hatched and planted. An experimental shipment of pollock eggs from Gloucester to Boothbay Harbor was intended to prepare the way for regular consignments on occasions when the Gloucester hatchery is overflowing. The pollock eggs, arranged on trays surrounded by snow and rockweed, and packed in a field shipping case, arrived in good condition after a 12-hour railway trip and hatched with normal loss. Haddock eggs to the number of 332,740,000 were obtained; 127,190,000 of these had to be planted owing to the low density of the hatchery water, the remainder producing 129,400,000 fry.

The possibility of saving enormous numbers of eggs of marine fishes by placing spawn takers on fishing vessels was experimentally tested in March and April, 1919. Three spawn takers were detailed to accompany fishing craft to Georges Bank with instructions to take eggs from any ripe cod and haddock that might be caught, fertilize, measure, and plant them overboard. As a result of seven trips, 73,200,000 haddock eggs and 58,950,000 cod eggs were thus treated. Two men made four trips on trawl-line vessels and took 32,600,000 haddock eggs and 26,280,000 cod eggs during 46 days. One man spent 30 days on three trips on an otter trawler, and during that time secured, fertilized, and planted 40,600,000 haddock eggs and 32,670,000 cod eggs. The value of work of this nature would seem to depend on the active cooperation of the fishing vessels. If the operations are to be of a magnitude that will make them worth while, a man or several men on each fishing vessel should be assigned the task of fertilizing the eggs of the ripe fish brought aboard the vessel.

## LOBSTER HATCHING.

Lobster hatching has practically been abandoned. The Bureau was never able to conduct it on a scale sufficiently extensive to produce any noteworthy effects on the supply, in the face of incessant fishing and a very general disregard for provisions of law affecting egg-bearing and short lobsters.

From the remnant of 8,000,000 lobster eggs carried over from the previous year's operations at the Boothbay Harbor station, 7,500,000 larval lobsters were produced and liberated in local waters in July. At the request of the Maine authorities, 2,000 stripped lobsters which the State had purchased and still owned were held at the Bureau's pound at Pemaquid from the beginning of the fiscal year until September. When the lobsters were collected, it was discovered that a very heavy mortality had resulted, only 624 lobsters being found.

Lobster hatching in recent years was possible only under conditions that violated fundamental principles of business and biology. The Bureau was willing to continue the work year after year in the hope of bringing about a widespread observance of law by affording the fishermen a means of disposing of their berried lobsters and by constantly keeping before the fishermen the need for saving the lobster eggs and immature lobsters. This course, however, could not be indefinitely continued under prevailing conditions, and Congress has now placed such limitations on the expenditure of the fish-cultural appropriation as to make it doubtful whether the lobster hatching can be legally conducted in the existing situation.

The outlook for the lobster from the standpoint of the public is distinctly gloomy in most sections, but the fishermen, as a rule, are well satisfied so long as the present outrageous prices prevail. A recent episode, doubtless typical of numerous communities, serves to indicate how difficult is the task that confronts the State officials. The lobstermen of a certain locality were called together and informed of the desire of the State to secure their support in carrying out the provisions of law for the protection of egg-bearing and short lobsters. The meeting then voted on the proposition, and more than 80 per cent of the lobstermen in the community signified their intention to continue to ignore the law.

The small appropriation made by Congress in an act approved July 1, 1916, for a lobster-rearing plant proved entirely inadequate, even when the capacity of the proposed plant was materially reduced from time to time in an effort to bring it within the appropriation. Request for a supplemental appropriation was not approved by Congress. In these circumstances, the appropriation has been turned back into the Treasury in the expectation that the project may be revived later.

## RESCUE OF STRANDED FOOD FISHES.

An outgrowth of the fish-cultural work that has assumed very great value and importance is the salvaging of food fishes from landlocked ponds, pools, and bayous in overflowed districts of the Mississippi valley. These fish, in the natural course of events, are destined to perish and be entirely wasted when the shallow ponds in which they have been left by the receding waters become dry or frozen. During the fiscal year 1919 headquarters for rescue work were established at eight points on the Mississippi extending from Minnesota and Wisconsin to Mississippi and Arkansas; and seining parties from the various fish-cultural stations and the biological station at Fairport covered a wide extent of territory and made collections in excess of those of any previous year. Especially effective work was done from Homer, La Crosse, Bellevue, and North McGregor. When the season closed about December 1, there had been salvaged over 55,000,000 young fishes, representing practically every important species inhabiting those waters, with buffalofish, carp, catfish, crappie, and yellow perch predominatiug, as shown in the following table:

FISHES RESCUED FROM OVERFLOWED WATERS OF THE MISSISSIPPI VALLEY DURING THE FIRST SIX MONTHS OF THE FISCAL YEAR 1919.

| | |
|---|---|
| Black bass, largemouth | 445,954 |
| Black bass, smallmouth | 2,190 |
| Buffalofish | 2,590,335 |
| Carp | 19,748,562 |
| Catfish | 12,607,446 |
| Crappie | 15,805,549 |
| Drum | 18,977 |
| Pike | 375,937 |
| Pike perch | 10,710 |
| Rock bass | 810 |
| Sunfish | 1,065,652 |
| White bass | 8,665 |
| Yellow bass | 600 |
| Yellow perch | 2,354,438 |
| Miscellaneous | 747,250 |
| Total | 55,783,075 |

Practically all the fishes thus saved are replanted in the adjacent public waters, but a few are consigned to applicants in various States. In 1919, 55,173,000 fish, more than 98.9 per cent of the total collections, were restored to the Mississippi and tributaries.

Plans have been completed for conducting these operations on a larger scale than heretofore during the fiscal year 1920, and the indications are that the results in 1919 will be more than doubled. The extent of the work that may be accomplished depends mostly on the funds that are available. There are productive fields yet untouched, especially in the central section of the Mississippi valley, and the saving of these valuable food resources by systematic annual rescue work is of vital importance to the maintenance of the fisheries of the region. The Bureau will expand its efforts to the full limit of financial possibility, and should be reinforced by all the States, some of which up to the present time have exhibited no interest and assumed no responsibility.

## SOME NEEDS OF THE FISH-CULTURAL SERVICE.

Among the more urgent needs in the Bureau's fish-cultural work is an increase in the number of hatcheries. The new establishments are desired for States or regions not now provided with hatcheries or only inadequately served by existing hatcheries. In addition to the foregoing, there should be several salmon hatcheries provided for Alaska.

There should be congressional recognition of the invaluable service rendered by the Bureau in salvaging food fishes in the overflowed districts of the Mississippi Basin, and liberal financial provision should be made for its continuance and extension.

Throughout the fish-cultural service there is an underpaid personnel. If the standard of efficiency is to be maintained there must be provided at once a revised salary scale that will retain desirable men and induce others to enter the various grades. Noteworthy results in the artificial propagation of aquatic animals and in the stocking of our interior and coastal waters can not reasonably be expected from a staff that in many cases is changing more quickly than appointment papers can be prepared and delivered.

## ARTIFICIAL PROPAGATION OF FRESH-WATER MUSSELS.

The active efforts taken by the Bureau to maintain by artificial means the supply of pearly fresh-water mussels, on which depend important fisheries and an extensive button-making industry, have presented the usual aspects. The work is conducted under the supervision of the fisheries biological laboratory at Fairport, Iowa, at various favorable points in the Mississippi Basin from Arkansas northward.

During the fiscal year 1919 about 136,907,365 young mussels, or glochidia, in a condition of parasitism on fishes, were liberated in public waters as compared with 209,132,825 liberated in the previous year. This decrease was due chiefly to unsatisfactory labor conditions, which made it difficult to keep efficient seining crews steadily employed, with a resulting reduction in the fish catch. The principal reduction was in the Lake Pepin field, the output of which was 35,423,125, as compared with 91,226,800 in 1918.

Four species of commercial mussels were propagated, the leading ones being the common mucket (*Lampsilis ligamentina*) and the Lake Pepin mucket (*Lampsilis luteola*), the others being the yellow sand-shell (*Lampsilis anodontoides*) and the pocketbook (*Lampsilis ventricosa*). The inoculated fish hosts were liberated in the Mississippi River off Fairport, Iowa; in Lake Keokuk, Iowa; at New Boston and Oquawka, Ill.; in the Mississippi River at Lake Pepin, Minn. and Wis.; in Lake Pokegama, Minn.; and in the Black River in the vicinity of Pocahontas and Clover Bend, Ark.

The cost of production during the year was $0.0689 per thousand, practically double that of the previous year. The increased cost was due to the greater cost of labor, equipment, and materials. Overhead charges and an allowance for depreciation amounting to $0.0236 per thousand are included in this computed cost. In connection with this work, 51,600 adult and 653,600 fingerling fishes were reclaimed from landlocked waters in the overflowed lands and liberated in public waters. Of the fishes rescued, 150,949, or approximately 21 per cent, were infected with larval mussels before release.

Experimental plants of adult mussels from the Mississippi River and from Lake Pepin were made in the Roanoke and Shenandoah Rivers in Virginia.

The following table shows the details of the work of artificial propagation:

MUSSEL PROPAGATION 1919, SHOWING NUMBER OF EACH SPECIES PLANTED AND POINTS OF DEPOSIT.

| Species. | Lake Pokegama, Minn. | Mississippi River at Lake Pepin, Minn. and Wis. | Mississippi River at Fairport, Iowa. | Mississippi River at New Boston, Ill. |
|---|---|---|---|---|
| Yellow sand-shell | | | | 193,000 |
| Mucket | | | 15,634,000 | 10,200,540 |
| Lake Pepin mucket | 21,632,100 | 34,463,300 | | |
| Pocketbook | | 959,825 | | |
| Total | 21,632,100 | 35,423,125 | 15,634,000 | 10,393,540 |

| Species. | Mississippi River at Oquawka, Ill. | Mississippi River at Lake Keokuk, Iowa and Ill. | Black River, Ark. | Total. |
|---|---|---|---|---|
| Yellow sand-shell | 36,000 | | | 229,000 |
| Mucket | 20,661,000 | | 14,525,500 | 61,021,040 |
| Lake Pepin mucket | 7,845,000 | 10,757,100 | | 74,697,500 |
| Pocketbook | | | | 959,825 |
| Total | 28,542,000 | 10,757,100 | 14,525,500 | 136,907,365 |

## ALASKA FISHERIES SERVICE.

### GENERAL CHARACTER OF THE SERVICE.

The duties devolving on the Bureau in connection with the general fisheries of Alaska include the enforcement of law and regulations with regard to the salmon fisheries, the collection of statistics and the dissemination of statistical and other information, the inspection of private salmon hatcheries, the investigation of the aquatic resources, the improvement of the physical condition of salmon streams, the holding of public hearings on proposed regulations for the protection of the salmon supply, and the submittal to the Secretary of Commerce of recommendations embodying modifications of existing regulations.

During the calendar years 1917 and 1918 the Bureau, in cooperation with the Washington-Alaska military cable and telegraph system of the War Department, informally maintained for the benefit of the fishermen of Alaska an intelligence service which covered the towns of Ketchikan, Juneau, Petersburg, Wrangell, Sitka, Skagway, Valdez, Seward, and Cordova. The information thus furnished daily appears to have been of value, and the service met with approval throughout Alaska. Being desirous of extending this work and having it receive official recognition from Congress, the Bureau submitted an estimate for an appropriation of $600 for the establishment in Alaska of a local fishery intelligence agency. The appropriation was not made, the work was not authorized, and the Bureau was criticized for the efforts already put forth.

A comprehensive report on the fisheries of Alaska and the Bureau's activities in relation thereto has been prepared by the chief agent of the Alaska service and has been published as a public document under the title "Alaska Fisheries and Fur Industries in 1918." This report should be consulted by those who desire detailed information.

### MAGNITUDE OF THE ALASKAN FISHERIES IN 1918.

When the 1918 season closed, a new record was established in the fisheries of Alaska, for every branch of the industry advanced over the year which had previously shown the highest development, namely, 1917. The following figures for 1918, with comparisons for 1917, show the persons employed, the capital invested, and the value of the product as prepared for market:

| Items. | 1918 | 1917 | Increase of 1918 over 1917. |
|---|---|---|---|
| Persons employed | 31,213 | 29,491 | 1,722 |
| Investment | $73,750,789 | $54,937,549 | $18,813,240 |
| Value of output | $59,154,859 | $51,466,980 | $7,677,879 |

It is the salmon industry which gives to the fisheries of Alaska their great importance, and it was the salmon industry that contributed most notably to the increases that occurred in 1918. The value of all salmon products was $53,514,812, of which $51,041,949 represented canned fish to the number of 6,605,835 cases. Thus, 50 years after Alaska became a part of our national domain, the salmon resources alone yielded a product valued at over 7½ times the purchase price of the territory. The 135 salmon canneries in operation were 17 more than in 1917. The changes in apparatus of capture included an increase in pound and trap nets and seines and a decrease in gill nets. The relative importance of the different kinds of gear remained about the same. Seines took 38 per cent of the salmon in southeast Alaska and 39 per cent in central Alaska, but only 4 per cent in western Alaska; pound trap nets are credited with 58 per cent, 48 per cent, and 4 per cent in the respective regions; while gill nets, which took only 2 per cent in southeast Alaska and 11 per cent in central Alaska, took 90 per cent in western Alaska.

The number of salmon taken for commercial use in Alaska in 1918 was 101,454,688, against 92,600,495 in 1917. The red salmon aggregated 35,338,065, and the output decreased 1,158,982; the humpbacks or pinks numbered 48,316,362 and increased 3,441,091; the cohos or silvers numbered 2,911,681 and increased 807,428; the catch of chums, ranking third, amounted to 14,160,818 fish, an increase of 5,633,240; while of the kings, the largest species, 727,762 were taken, an increase of 131,416 over the previous year. The total catch in southeast Alaska was less than in 1917, while both central and western Alaska showed a larger output. Placed end to end, the salmon taken in Alaska in 1918 would extend more than 1½ times around the world at the equator.

Owing to increased attention received during 1918 by the herring, the output of that species took second rank among the fisheries of Alaska, displacing the halibut, which for many years had held that position. The advance was due to a greatly increased pack of pickled herring, in response to the Bureau's efforts to introduce and establish the Scotch cure in Alaska. This stimulus to the herring industry was exhibited also in the much larger quantity of herring pickled after the Norwegian method, which had previously been the only one followed. The year's herring output was valued at $1,819,538, of which amount $748,605 represented Scotch-cured herring.

The Alaska halibut fishery in 1918 was engaged in by 118 steam and gas vessels, and represented an investment of $2,594,292. The catch, amounting to upward of 13,869,000 pounds, valued at $1,667,686, exceeded the 1917 output by 716,000 pounds and $547,000.

The cod fishery has shown but slight fluctuation in recent years. In 1918 the vessel catch in Bering Sea, usually about two-thirds of the total output, was somewhat under that of the previous season, while the catch at the shore stations, chiefly on the southern shore of the Alaska peninsula, was sufficiently increased over 1917 to offset the vessel shortage. The aggregate output of the cod fishery was upward of 14,000,000 pounds, valued at $957,000. Dry-salted fish constituted the bulk of the products, namely, nearly 11,000,000 pounds, with a market value of $778,000.

The only other branch of the Alaska fisheries of prime importance is whaling, which is conducted wholly from shore stations. The number of whales taken was 448, most of which were finbacks; this was 25 more than in 1917. The value of all whale products was $834,000.

## FISHERY PATROL.

The patrol maintained by the Bureau during the fishing season of 1918, while by no means adequate or satisfactory, was more effective and comprehensive than ever before. The regular vessels were supplemented by hired craft and the regular force of wardens and agents was augmented by special employees, as far as the funds available would permit.

A detailed statement of the work of the patrol in 1918 in detecting violations of laws and regulations and in prosecuting the offenders in the Alaskan courts is given in the special report on the activities of the Alaska service for that year. There have been numerous convictions, mostly for failure to observe the weekly close season, for setting gear within prohibited distances of other gear, for fishing in closed waters, etc., and substantial fines have been imposed.

The great need of the Bureau in its task of enforcing laws and regulations for the protection and control of the salmon fisheries of Alaska is larger appropriations for providing additional facilities in men and vessels, so that every important fishing district may be fully covered.

Late in the fiscal year, plans were made to inaugurate a vigorous patrol for the fishing season of 1919, but these for the most part could not be put into effect until the season was well advanced, owing to the failure of the appropriations to become available. Among the new features of the 1919 patrol was the use by the Navy Department, at the solicitation of the Department of Commerce, of submarine chasers in enforcing the fishery laws and regulations, employees of the Alaska service being carried on these vessels.

## NEW REGULATIONS FOR SALMON FISHERIES.

Following announcements and hearings in accordance with law, and on the recommendation of the Commissioner of Fisheries, the Secretary of Commerce has promulgated orders providing new regulative measures for the perpetuation of the salmon supply in streams of southeastern Alaska, the Copper River, and the Yukon River. The text of the several orders is as follows:

### SOUTHEASTERN ALASKA WATERS. (ORDER PROMULGATED DEC. 21, 1918.)

A hearing having been given at Seattle, Wash., November 25, 1918, after due notice in accordance with law, for the purpose of determining the advisability of making salmon-breeding reserves of certain waters in Alaska, and all persons having had full opportunity to be heard, it is hereby ordered, by virtue of the authority vested in me by section 6 of "An Act for the protection and regulation of the fisheries of Alaska," approved June 26, 1906, that until further notice all fishing for salmon, or other fishing in the prosecution of which salmon are taken or injured, in all hereinafter-described waters of southeastern Alaska east of the longtitude of Cape Spencer, be and is hereby made subject to the following limitations and prohibitions in addition to the general restrictions already applicable by virtue of existing laws and regulations:

1. That fishing with all forms of apparatus is prohibited in all streams less than 500 feet in width at the mouth at mean low tide and in all lakes and other waters tributary to such streams.
2. That all fishing with purse seines and drift gill nets and all other movable fishing appliances, other than set nets and beach seines, is prohibited within 200 yards outside the mouth at mean low tide of all streams less than 500 feet in width at their mouth, except at the mouths of the Chilkat and Chilkoot Rivers, where the prohibited distance for all fishing appliances shall be 500 yards.
3. That all fishing with traps, stake nets, and other fixed fishing appliances, and set nets and beach seines is prohibited within 500 yards outside of the mouth at mean low tide of all streams less than 500 feet in width at their mouth. No exceptions will be made in favor of any fixed fishing appliances heretofore operated within the prohibited areas.
4. That the driving of salmon downstream and the causing of salmon to move outside the protected area at the mouth of any stream are expressly prohibited.
5. That this order does not supersede but supplements sections 3 and 4 of the order promulgated by the Secretary of Commerce on November 18, 1912, which, respectively, prohibit all commercial fishing for salmon or other fishing in the prosecution of which salmon are taken or injured "in Anan or Humpback Creek, its lagoon, lakes, and tributary waters, together with the region within 500 yards of the mouth of said creek," and "in Naha stream, its lagoon, lakes, and tributary waters, above a line connecting the points known respectively as Loring Point and House Point." Likewise this order does not supersede but supplements the order promulgated by the Secretary of Commerce on October 25, 1915, which similarly prohibits fishing (*a*) "in all waters tributary to Barnes Lake, Prince of Wales Island," (*b*) "in Hetta Creek, its tributary waters, and the region within 500 yards of the mouth of said creek," and (*c*) "in Sockeye Creek, its tributary Boca de Quadra hatchery waters, and the region within 500 yards of the mouth of said creek."

This order becomes effective January 1, 1919.

### COPPER RIVER. (ORDER PROMULGATED DEC. 20, 1918.)

A hearing having been given at Seattle, Wash., November 22, 1918, after due notice in accordance with law, for the purpose of determining the advisability of amending the order of December 29, 1917, effective January 1, 1918, establishing a salmon-breeding reserve and limiting fishing in the Copper River, Alaska, its delta and its tributary waters, and all persons having had full opportunity to be heard, it is hereby ordered, by virtue of the authority vested in me by section 6 of "An Act for the protection and regulation of the fisheries of Alaska," approved June 26, 1906, that until further notice all fishing for salmon or other fishing in the prosecution of which salmon are taken or injured, in the Copper River and its delta and all tributary waters, Alaska, be and is hereby made subject to the following limitations and prohibitions in addition to the general restrictions already applicable by virtue of existing laws and regulations:

1. Commercial fishing is prohibited in waters of the Copper River delta from 6 a. m. on January 1 to 6 a. m. on June 10 of each year, and in the waters of Miles Lake and Abercrombie Canyon from 6 a. m. on January 1 to 6 a. m. on June 15 of each year.

2. Commercial fishing in the waters of the delta shall be limited to set nets and drift gill nets. No such net shall exceed 800 feet in length. The lateral distance interval between all set nets in the waters of the delta herein referred to shall be not less than 600 feet.

3. All fishing is prohibited from the head of the delta to the foot of Miles Lake at all times.

4. All fishing in Miles Lake shall be limited to set nets. No such net shall exceed 800 feet in length, and only one such net shall be extended out from shore from one location. No offshore nets will be permitted in the lake. Throughout the fishing season the shore of the lake shall be considered as it was on June 15. The lateral distance interval between all nets in Miles Lake shall be not less than 600 feet. No fishing will be permitted along the west and north shores of Miles Lake from the north end of Mile 49 bridge to the north end of Miles Glacier, nor along the islands and sand bars between the bridge and the head of the lake.

5. Fishing in Abercrombie Canyon shall be restricted to the use of dip nets operated by hand, such nets not to exceed 16 inches in greatest diameter. No fishing will be permitted at any point on the east side of the canyon or river above the head of the lake.

6. No fishing will be permitted at any time in the waters of the Copper River above Abercrombie Canyon, or in any of the waters tributary thereto, except in the case of local residents who may take limited numbers of salmon for domestic use: *Provided*, That such fishing shall at no time be upon the spawning grounds of any salmon.

7. No net shall be placed in any other than substantially a straight line.

8. For the purposes herein considered, the delta of the Copper River shall be regarded as including all waters south of an east and west line passing through Mile 27 on the Copper River & Northwestern Railway, as at present established, and inside of a line 500 yards off the mouth of each slough and outlet of the Copper River beginning with Alaganik Slough on the west and ending with Gus Wilson Slough on the east, including Pete Dahl, Walhalla, Gus Stevenson, Little King Salmon, Castle, Storey, Big King Salmon (or Copper River proper), Duck, Russian, and all unnamed sloughs between. For the purposes of this order, the mouth of each slough will be regarded as at the edge of the grass banks at the line of mean high tide.

9. The lower end of Miles Lake shall be considered as at the bridge of the Copper River & Northwestern Railway at Mile 49. The head of Miles Lake shall be considered as at the point where the river enters the lake, this point to be as indicated by notices posted by duly authorized representatives of the Bureau of Fisheries.

10. Abercrombie Canyon shall be considered as extending from the head of Miles Lake to Tunnel Point on the Copper River & Northwestern Railway.

11. For the purposes of this order the following definitions are adopted: "Stake net," a gill net attached or affixed to piles or stakes. "Set net," an anchored gill net, one end of which may if desirable be fastened to a stake or other object on shore.

This order becomes effective January 1, 1919, and supersedes the order of December 29, 1917.

### YUKON RIVER. (ORDER PROMULGATED DEC. 14, 1918.)

A hearing having been given at Seattle, Wash., November 20, 1918, after due notice in accordance with law, for the purpose of determining the advisability of establishing a salmon-breeding reserve of certain waters in Alaska, and all persons having had full opportunity to be heard, it is hereby ordered, by virtue of the authority vested in me by section 6 of "An Act for the protection and regulation of the fisheries of Alaska," approved June 26, 1906, that until further notice all fishing for salmon or other fishing in the prosecution of which salmon are taken or injured, in the Yukon River and all tributary waters, and in all waters of its delta to and including the area 500 yards outside each mouth or slough of the delta at mean high tide, be and is hereby made subject to the following limitations and prohibitions in addition to the general restrictions already applicable by virtue of existing laws and regulations:

1. That in 1919, and in each year thereafter unless otherwise ordered in the manner prescribed by law, not to exceed 30,000 cases (48 one-pound cans per case, or the equivalent thereof) of canned salmon, 1,000 barrels (200 pounds net weight each) of pickled or hard-salted salmon, and 200 tierces (800 pounds net weight each) of mild-cured salmon, of all species, shall be prepared for commercial purposes or export; these quantities to be apportioned, after a conference with the local representative of the Bureau of Fisheries, as equitably as practicable among the persons or companies with established plants. Promptly at the end of each calendar week each individual or company shall submit a statement to the said representative of the Bureau of Fisheries showing the number of cases, barrels, and tierces of salmon thus prepared to date, and shall submit also a record of the number of salmon of each species taken daily.
2. That no salmon to be prepared by canning, pickling, or mild curing for shipment from Alaska shall be caught above the junction of the Clear River with the Yukon River near Andreafski.
3. That commercial fishing in the waters of the Yukon delta shall be limited to Kwikluak Pass, commonly known as the south mouth or channel.
4. That the use of traps or pound nets in the Yukon River and its delta is prohibited.
5. That no gill net, seine, or other net used in the Yukon River and its delta shall exceed 700 feet in length.
6. That all commercial fishing, except for local requirements, is prohibited after August 31 of each year.

This order becomes effective January 1, 1919.

## PRIVATE SALMON HATCHERIES.

In conformity with law, the two private salmon hatcheries operated by canning companies in southeastern Alaska have been inspected, their methods have been approved, and the issuance of tax rebate certificates has been recommended. The hatcheries on Naha Stream and Quadra Lake liberated 35,057,000 red-salmon fry in the year ending June 30, 1919, and were entitled to remission of taxes to the amount of $14,022.80. A third private hatchery, on Hetta Lake, was not running in the year named.

The conditions under which the private salmon hatcheries were established and have since been allowed a rebate of taxes in proportion to the number of red-salmon fry hatched and planted no longer carry weight. The owners should be relieved of this responsibility, and such hatcheries as may be necessary should be Government owned and operated. The existing hatcheries, if found desirable, should be taken over by the Government at a fair valuation.

## COMMERCIAL FISHING IN ALASKAN RESERVATIONS.

During the fiscal year 1919, the Secretary of Commerce, on the recommendation of the Bureau, issued five permits for fishing operations in the Aleutian Islands Reservation, pursuant to the regulations issued jointly by the Departments of Commerce and Agriculture under the terms of the Executive order of March 3, 1913. The number of such permits in force on June 30, 1919, was 24.

In the Afognak Reservation licenses were issued to about 45 natives who desired to engage in commercial salmon fishing. They made a fair catch and had good financial returns owing to the action of the Food Administration in fixing the price of salmon at a higher figure than the natives had ever before received. The number of salmon taken was 126,700, of which 70,790 were humpbacks and

50,660 were sockeyes. Most of the catch was sold to a fishing company at Kodiak. The natives seem satisfied with the Bureau's plan for apportioning the fishing grounds among the fishermen, so that overfishing is prevented and all enjoy an equal opportunity.

### ALASKA FISHERY LEGISLATION.

For about eight years legislation affecting the fisheries of Alaska has been pending in Congress. Protracted hearings have been held, and a large amount of testimony and data has been presented to the appropriate committees of the two houses. The necessity for a radical revision of the existing salmon law has been especially pointed out by various agencies and persons interested in the welfare of the fisheries of Alaska, and congressional committees have made favorable reports on bills embodying new legislation.

No new fishery laws have, however, been enacted; and the fisheries of Alaska, at the most critical period of their history, remain subject to laws which have been shown to be obsolete and inadequate. The Bureau of Fisheries is thus placed at a great disadvantage in administering the salmon fisheries of Alaska and can not justly be held accountable for conditions, practices, and developments which, while having the full sanction of law, are not necessarily compatible with the perpetuation of the supply and in some respects are directly opposed thereto.

The law of June 14, 1906, prohibiting aliens from engaging in the fisheries of Alaska, should be amended so as to give full force to its beneficent purpose. The high prices recently commanded by salmon have attracted an unusually large number of persons to the fisheries of Alaska, including many aliens. Instances have come to light where persons who renounced their declaration of intention to become citizens in order to escape the selective draft, and have not since changed their civic status, are claiming or exercising the privilege of operating independently in the fisheries of Alaska, a right that should be restricted to bona fide citizens.

It is the consensus of opinion among persons well informed regarding the halibut fishery conducted off the Alaskan coast that there are wasteful features of the fishery which are imperiling the halibut supply. The situation is difficult to handle, but at least one measure of protection is feasible and meets with general approbation, namely, a close season during several winter months when the fishery is most hazardous, least productive, and most wasteful. This matter was fully considered by the American-Canadian Fishery Conference which held hearings on the Pacific coast in 1918 and recommended remedial legislation which, to be effective, should be uniform in the United States and Canada. This matter should receive the early attention of Congress.

## ALASKA FUR-SEAL SERVICE.

### OUTLINE OF ACTIVITIES.

In the general administration of the Pribilof Islands, the duties devolving on the Bureau are extremely varied. They comprise (1) the purchase, transportation, and distribution of supplies for the natives of the seal islands; (2) the transportation of Government employees and natives to and from the islands; (3) the maintenance of schools; (4) the maintenance of a medical staff; (5) the general care of the natives; (6) the handling and investment of funds belonging to the natives; (7) the care of buildings and other Government property; (8) the supervision and protection of the seal herds; (9) the maintenance of a patrol for the protection of the islands against possible raids; (10) the taking, preserving, packing, shipping, and selling of sealskins; (11) the operation of a by-products plant for utilizing seal carcasses; (12) the protection and care of herds of blue foxes, and the taking, shipment, and sale of their pelts; (13) the care, utilization, and improvement of reindeer herds; (14) the construction of roads, the maintenance of proper sanitary conditions, the improvement of landing facilities, etc. The activities in these and other lines are discussed at length in the report entitled "Alaska Fisheries and Fur Industries in 1918," by the chief agent of the Alaska service.

The advance in the cost of practically every article required for the Pribilof Islands has for several years necessitated a reduction in the requisitions to a point that makes impossible the purchasing of any reserve supplies. When, as in 1919, the passage of the bill carrying the appropriation for this service is delayed until midsummer, a serious situation arises from the exhaustion of the stocks of food, medicine, fuel, and clothing. This emphasizes the need for a substantial reserve supply of indispensable commodities, to be used in emergencies, and should give force to the Bureau's appeal to Congress for a small special appropriation for this purpose.

Most of the supplies destined for the Pribilof Islands and the products therefrom were transported on the Bureau's steamer *Roosevelt*, which made two voyages to the islands during the fiscal year. In the spring of 1919 the *Roosevelt* was surveyed with a view to determining necessary repairs. It was found that dry-rot had started in the ship's timbers to such an extent as to make repairs inadvisable. The vessel was accordingly sold at public auction at Seattle on July 15, the sum of $28,000 being realized.

The appropriation of $20,000 that became available on July 1, 1918, for the construction or purchase of a power vessel for the Pribilof Islands proved inadequate, and Congress subsequently provided a supplemental appropriation of $7,500. This has enabled the Bureau to obtain by purchase an acceptable craft, which will be extremely useful.

The increase in the seal herd and in the commercial sealing operations, taken in connection with the important international aspects of the matter, warrant and demand the presence at the islands of an increased personnel competent to deal with the seals in the most efficient manner from the scientific and industrial standpoints. In the estimates of appropriations for the fiscal year beginning July 1, 1920, provision is made for additional members of the staff, including a superintendent, to have general direction and coordinate the administrative affairs of the Pribilof Islands, and a biologist whose continuous studies and observations would be the Bureau's guide in the management of the seals and other animals of the islands. The recent acquisition of means for independent interisland communication at all times makes possible the employment, to better advantage than formerly, of general officials.

## CONDITION OF THE FUR-SEAL HERD.

The growth of the seal herd under the conditions now existing is continuous and satisfactory, averaging about 10 per cent annually. The census in recent years has been under the supervision of Dr. G. Dallas Hanna, and represents a vast amount of painstaking field and office work. The methods of the census, the basis for the various computations and estimates, the results, and a discussion of the figures and their significance may be found in the report cited in a special section devoted to the census.

The revised figures of the 1918 census indicated that the seal herd comprised 496,432 animals of all ages as of date of August 10, in addition to 33,881 seals taken for commercial purposes during the year. The unrevised but substantially correct figures of the 1919 census give the full strength of the herd, as of date of August 10, as 524,260 seals of all ages, exclusive of 26,390 taken for commercial purposes during the census year, a net increase of 27,828. The number of pups born in 1919 was 157,172, as against 142,915 in 1918, the respective figures for breeding cows being the same.

The great disproportion in the number of old male seals, arising from the total prohibition of commercial sealing during the period of five years ending in 1917, has occasioned much concern and received special consideration. In the taking of seals, efforts have been directed to the establishment of a proper proportion of breeding animals, through a reduction in the number of old surplus males.

## QUOTA AND TAKE OF SEALSKINS.

The 1918 quota of seals to be killed was first fixed at 25,000 and later increased to 35,000. The number actually taken to August 10 was 33,881, 26,881 on St. Paul Island and 7,000 on St. George Island; in addition to which there were taken on St. Paul Island 622, and on St. George 387, a total of 1,009 seals, in the fall of 1918 for the food purposes of the natives.

The quota for 1919 was set tentatively at 35,000 skins, but the number taken through August 10 was only 25,381, of which 22,027 were on St. Paul Island and 3,354 on St. George Island. Seals were present in sufficient numbers easily to meet the quota, but there was a scarcity of labor on the islands owing to the quarantine during the influenza epidemic, which prevented the transportation of additional native workmen from the Aleutian Islands, and also made it impossible for white assistants from St. Louis to reach the Pribilofs. Furthermore, there was much additional labor involved in taking and handling the skins of the larger surplus seals whose utilization is demanded. These circumstances reduced the number of skins that could have been taken under normal working conditions.

## FOXES AND REINDEER.

The blue foxes of the Pribilof Islands are regarded as having fur of better quality than those from any other region. They are trapped, under careful supervision, during a short period in winter, the natives being paid $5 apiece for each fox skin secured. The foxes on St. George Island are more numerous and in better physical condition than on St. Paul Island. In the winter of 1918–19 trapping was conducted for five days in December on St. Paul Island, and 119 blue-fox and 25 white-fox pelts were obtained. On St. George Island trapping was done during parts of December, January, and February, and 548 blue and 5 white pelts were taken. Efforts are being directed to the improvement of the breed of foxes on St. Paul Island.

The reindeer, of which 40 were introduced on the Pribilofs in 1911, have flourished and increased, and the surplus males are now furnishing a limited amount of fresh meat. It is believed that in a short time, with the present rate of increase, these animals will become a much more important factor in the food supply. In the summer of 1918 there were on St. Paul Island 160 reindeer, including 40 fawns, while St. George Island reported 114 reindeer of all ages at the end of the calendar year. Twenty animals were used for food on both islands in 1918.

### RECEIPTS FROM SALE OF PRODUCTS.

During the calendar year 1918 two public auction sales of fur-seal skins were held at St. Louis by Funsten Bros. & Co., agents of the Government. The skins, numbering 8,100 and representing seals taken during 1917, were offered in a dressed, dyed, and machined condition, ready to be made into garments; the gross price received was $375,385, an average of $46.34 per skin. The net proceeds were $257,333.21. A feature of each sale was a small lot of "wigs"—skins of the largest size, taken from old bulls—which brought the highest prices, although in former years, when "wigs" were disposed of abroad in a raw state, they were in little demand and were sold at only $6 to $10. The demonstration by Funsten Bros. & Co. that the skins of old bulls have an excellent fur and that they can be made available for all the purposes for which the pelts of younger males are used is one of the most interesting and important developments of the American sealskin industry.

In the calendar year 1919 there have been two auction sales of sealskins taken in the previous calendar year. The skins numbered 15,275, and the net proceeds therefrom amounted to $1,026,728.84. At the last sale, held in September, the average price of sealskins was $91.35, an advance of 30 per cent over the first sale, in April. The estimated net value of all the seals taken in 1918, allowing for the unsold skins at the prices received at the September sale, is $2,467,334.45.

The fox pelts resulting from the previous season's trapping were sold at public auction in St. Louis on October 7, 1918. They numbered 692 blues and 19 whites, and brought $57,099.50 and $1,080, respectively, gross, and $51,898.64 net for the two grades. The average gross price for blues was $82.51. The fox pelts taken during the fiscal year 1919 were sold on September 10, 1919, and brought the highest prices ever obtained, averaging $195.90 for blues, an advance of 135 per cent over the previous year's sale. The approximate net revenue from this sale is $123,285.

The seal-island natives have been encouraged to collect old seal bones when their other duties permit, and are paid for such collections. During 1918 they obtained about 300,000 pounds, which were shipped to Seattle and San Francisco on Government vessels and sold under contract, netting $3,891.03.

## MINOR FUR-BEARING ANIMALS OF ALASKA.

### COMMERCIAL VALUE OF THE MINOR FUR BEARERS.

The Bureau collects statistics of the furs shipped out of Alaska each year, using for this purpose special blanks that are supplied to postmasters, express offices, commercial companies, and individual shippers. Postmasters have cooperated effectively in securing full reports on all mail shipments, and the customhouse records are available for checking up other shipments.

The quantities of furs sent out of Alaska in 1918 were in excess of the records for previous years, with the exception of lynxes and foxes, and their value surpassed all other seasons. The compiled figures, exclusive of the fur seals taken on the Pribilof Islands, indicate $1,363,600 as the value of the furs shipped out of Alaska. Most important of the fur bearers were red fox, worth $342,496; white fox, $181,240; lynx, $199,992; mink, $159,718; and muskrat, $103,948.

Fur farming is receiving much attention in Alaska, but the results, as a whole, are not very satisfactory. The Bureau has had reports of many more or less unsuccessful ventures. Foxes are the favorite animals handled, with occasionally martens, minks, and muskrats. At the end of the calendar year 1918 three islands under the jurisdiction of the Department were under lease for the propagation of fur-bearing animals. A number of other islands are available for this purpose.

### REGULATIONS AND VIOLATIONS.

The 1917 regulations for the taking of fur-bearing animals were substantially unchanged for 1918. The period of total prohibition of beaver trapping was extended to November 1, 1923. On the recommendation of the Governor of Alaska and other disinterested persons, the open season for taking foxes in the region draining into the Arctic Ocean north of the sixty-eighth parallel was extended 30 days, so as to include April 14. On September 18, 1918, there was issued a new order prohibiting the use of dogs in pursuing or killing any fur-bearing animals for which a close season is prescribed.

There have been various prosecutions and seizures of furs for violation of the regulations for the protection of fur-bearing animals. The principal infractions of the regulations are sale of unprime skins obviously taken out of season and possession or sale of beaver, marten, and fur-seal skins. The confiscated furs have been disposed of at public auction in Seattle, and have yielded several thousand dollars in revenue to the Government.

### TRANSFER OF CONTROL.

The Bureau is administering to the best of its ability the laws relating to the terrestrial and arboreal fur bearers of Alaska, but the duty is incongruous to its legitimate functions. The pursuit of foxes does not constitute a fishery. The cultivation of minks can not be successfully conducted in a fish hatchery. If Congress desires to retain jurisdiction over these animals, control should be vested in the Bureau of Biological Survey of the Department of Agriculture. The proper alternative course would be to transfer the jurisdiction to the Territory.

## MISCELLANEOUS MATTERS.

### APPROPRIATIONS AND ALLOTMENTS.

The appropriations for the Bureau of Fisheries for the fiscal year 1919 aggregated $1,183,140, as follows:

| | |
|---|---|
| Salaries | $437,940 |
| Miscellaneous expenses: | |
| Administration | 10,000 |
| Propagation of food fishes | 400,000 |
| Maintenance of vessels | 95,000 |
| Inquiry respecting food fishes | 50,000 |
| Statistical inquiry | 7,500 |
| Protecting sponge fisheries | 3,000 |
| Protecting seal and salmon fisheries of Alaska (including deficiency of $44,700) | 144,700 |
| Improvements at the Berkshire (Mass.) trout hatchery | 2,500 |
| Establishment of an auxiliary hatchery, Lake Champlain | 5,000 |
| Vessel for Pribilof Islands (including deficiency of $7,500) | 27,500 |

A detailed statement of the expenditures under the regular and deficiency appropriations will be submitted in accordance with law.

Three allotments from the appropriation for the national security and defense were made by the President during the year, as follows: On July 2, 1918, $125,000 for a fishery-products laboratory in Washington, D. C.; on July 2, 1918, $25,000 for increasing the food-fish supply; and on January 11, 1919, $10,000 for the same purpose.

### VESSEL SERVICE.

The steamer *Roosevelt* reached Seattle on July 7, 1918, from the Pribilof Islands and at once made ready for another trip, taking on a miscellaneous cargo of general supplies, lumber, machinery, salt, coal, etc. Departure was made July 26, and the vessel arrived at Unalaska August 21, where she took on additional fuel and a shipment of salt which had been sent by commercial freight to that place. Two additional round trips between the island and Unalaska were made to transport the freight stored there. On the return voyage a large shipment of sealskins and a quantity of old bones were carried from St. Paul Island. Bad weather was encountered which prevented the bringing out of any products from St. George Island. The vessel reached Seattle at midnight, October 3. On her next voyage the *Roosevelt* left Seattle October 15, and arrived at the islands November 3. The landing of cargo was delayed by storms, and it was necessary to go to Akutan for additional fuel before discharging all freight. Final departure from the islands was made on December 12, the vessel reaching Seattle with a cargo of sealskins, bones, etc., on January 3, 1919.

On January 17 the master of the *Roosevelt* reported the vessel to be in need of overhauling, refitting, and repairs to put her in seaworthy condition, and this report was confirmed by officers in the Steamboat-Inspection Service who surveyed the vessel. Arrangements were made to have the required work done at the Bremerton Navy Yard, but an examination of the ship by construction officers of the Navy elicited the report that repairs amounting practically to rebuilding would be necessary to put her in satisfactory condition and that the cost and time involved would not be justified. Accordingly, on June 4 the *Roosevelt* was condemned and after the customary advertising was sold at public auction to the highest bidder on July 15, 1919, for $28,000.

Four vessels of the Bureau which were placed at the disposal of the Navy Department for the period of the war have been returned in good condition. It is understood that the military services of all, as part of the auxiliary fleet, were important and useful. The *Albatross* was under naval control from November 19, 1917, to June 23, 1919; the *Fish Hawk* from July 18, 1918, to July 1, 1919; the *Halcyon* from May 14, 1917, to August 5, 1919; and the *Phalarope* from December 6, 1917, to July 29, 1919. Both the *Fish Hawk* and the *Phalarope* were employed in Navy work for considerable periods prior to their being formally taken over.

With the special appropriation for a vessel for the Pribilof Islands, the power schooner *Eider* was purchased at Seattle for $26,500. This boat, formerly a deep-sea halibut vessel known as the *Idaho*, was built in 1913 and is of particularly seaworthy construction. She is 88 feet long, and 19 feet beam, and is equipped with a 110-horsepower Frisco standard engine with the usual auxiliary machinery and fuel tanks of sufficient capacity to give a cruising radius of 5,500 miles. She will be further equipped with wireless apparatus, and as part of her duty will be guarding the fur-seal rookeries, she will be furnished with a light gun.

There have been transferred to the Bureau by the Navy Department the motor boats *Enterprise* (S. P. 790), *Polly* (S. P. 690), *Cobra* (S. P. 626), and *Calypso* (S. P. 632). The two former will be used in fish-cultural work on the Maine coast, and at Cape Vincent, N. Y., respectively, and the two latter as patrol boats in southeast Alaskan waters.

## COOPERATION WITH OTHER GOVERNMENT AGENCIES.

The Bureau of Fisheries cooperates with numerous other Government bureaus, and is glad to acknowledge the helpful attitude which exists throughout the public service.

Relations of public importance have been maintained with the National Park Service, Department of the Interior, in Yellowstone and Glacier National Parks, where the Bureau conducts hatcheries and supplies fish for the stocking of park waters, while the National Park Service affords various facilities to this end. Shipments of fish are made to other national parks on the request of the proper officials. The attraction which the national parks have for the general public is increased by the angling facilities they afford; and the Bureau is in cordial accord with the movement to secure larger patronage for our unrivaled national recreation grounds.

The Bureau of Indian Affairs has entered into an agreement with the Bureau to promulgate better fishing regulations on the Quinault River in Washington, where a salmon hatchery is maintained for the benefit of the Indians. It became necessary to revise the regulations governing fishing by the Indians, and this was successfully accomplished after many conferences between officials of both bureaus.

The Reclamation Service has tendered assistance in planting fish in streams and reservoirs that come under its control, and has published articles prepared by the Bureau in regard to the stocking of waters.

The Forest Service has taken the greatest interest in the stocking of streams in forest reservations throughout the country. Its district forest supervisors have been receiving fish at the railroad stations and taking them back into mountain streams, by pack horse in many instances, in especially constructed cans belonging to the Forest Service. This work has extended throughout the Rocky Mountain region, to Minnesota and Wisconsin, to the White Mountains, and to the Alleghanies in North Carolina. The fish thus handled by the Forest Service are placed in mountain streams and such waters as are heavily fished by tourists, thus affording much pleasure to a large and appreciative public. The increased use of automobiles by touring parties, and the movement to construct good roads through the forest reservations are causing more people to seek the reservations each year, and angling is one of the principal attractions.

With the Bureau of Chemistry the Bureau has cooperated in the examination of various fishery foods, with reference to the correctness of labels and the suitability for human consumption. The two bureaus worked together in introducing half a million pounds of Gulf fish into interior markets.

The States Relations Service South of the Department of Agriculture and the Bureau of Fisheries have cooperated effectively in various ways, the principal one being in giving demonstrations of the methods of preparing and cooking fish; these demonstrations being at points in Florida, Mississippi, Georgia, and in Washington, D. C.

The Bureau of Animal Industry has cooperated with this Bureau in bringing about an increased production of fish meal and calling the attention of agriculturists to the value of this product as animal food. The part taken by the Bureau of Fisheries has been to interest persons in the fishery industries in the production of this product, while the Bureau of Animal Industry carries on feeding tests and finds markets for such material as is produced.

Reference is made elsewhere to the work of the Bureau, undertaken in connection with the Public Health Service, in eradicating mosquitoes in the extra-cantonment zone at Camp Hancock, Ga. Experiments in mosquito control are being jointly conducted by the Bureau of Entomology and the Bureau of Fisheries in Louisiana.

The Coast Guard has rendered invaluable service, as heretofore, in connection with the Alaska work of the Bureau, more particularly with regard to transportation of persons and supplies to the Pribilof Islands.

In October, 1918, the Coast Guard cutter *Bear* made a special trip to Seattle for the purpose of bringing out Assistant Agent A. C. Reynolds for urgent medical treatment. A small shipment of fur-seal skins from St. George Island was also carried. In response to a request from the Secretary of Commerce, on February 12, 1919, the Secretary of the Navy advised on March 3 that the commodore commandant of the Coast Guard had been directed to detail the cutters *Unalga* and *Bear* to maintain the usual patrol for the protection of the seal herd. The *Bear* sailed from Seattle on May 14 and carried as passengers for the Bureau four employees from the plant of Funsten Bros. & Co., who were to assist in the sealing work on the islands. A small quantity of emergency supplies also was transported. Because of the quarantine established on account of the epidemic of influenza, these passengers could not be landed at the islands by the *Bear* and were taken to Nome and subsequently returned to Seattle.

The Fuel Administration issued orders making it imperative that the Bureau's stations and distribution cars be supplied with coal in such quantities and at such times as might be required. Had this not been done many of the stations would have been compelled to shut down, and the car service would have been crippled in its efforts to distribute fish.

The Food Administration and the Bureau together worked out regulations governing fishing during the war period, and cooperated in other ways.

Respectfully submitted.

H. M. Smith,
*Commissioner of Fisheries.*

To Hon. William C. Redfield,
*Secretary of Commerce.*

# REPORT

OF THE

# COMMISSIONER OF LIGHTHOUSES

# REPORT

OF THE

# COMMISSIONER OF LIGHTHOUSES.

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Department of Commerce,
Bureau of Lighthouses,
*Washington, September 15, 1919.*

Sir: The following report is submitted of the operations of the Lighthouse Service for the fiscal year ended June 30, 1919:

## SUMMARY OF MORE IMPORTANT ACTIVITIES OF THE YEAR.

The cooperation of the Lighthouse Service in the war activities of the Government continued throughout the year, nearly all of the lighthouse tenders and a number of other units serving with the Navy Department and at the same time continuing the work of maintaining aids to navigation.

Three important new light and fog-signal stations were established—at Lorain Harbor, Ohio; Sand Hills, Lake Superior, Mich.; and Lime Kiln, San Juan Island, Wash.—and three unwatched lights were placed on dangerous shoals in the Caribbean Sea. There was a net increase of 400 in the number of aids to navigation maintained by the Lighthouse Service, and the total is now 16,075. In Alaska 36 additional aids were established, making the total there 475, of which 180 are lights and 8 gas buoys.

The retirement law for the field force of the Lighthouse Service was put into effect in November, 1918, when funds became available, and has proved of great benefit. It is the first retirement provision for a civilian service in this Government, and includes light keepers, vessel employees, etc.

Radio equipment was installed on a large number of vessels during the year, and telephone connections made with many light stations, so that at the end of the year 40 light vessels, 23 tenders, and 139 light stations were equipped for communication, this work having been done largely by the cooperation of the Navy and Coast Guard. These installations add greatly to the means of communication along the coast and are a valuable protection to this and other Government services and to vessels generally.

Two small gasoline-driven vessels were transferred from the Navy Department for use as tenders in protected waters, and a small tender was built for use in the inlets on the New Jersey coast and a working barge for construction on the Hudson River. These were the only additions to the vessels of the Service during the year, and of course were quite inadequate to offset the deterioration of the fleet of the Service through age and the actual losses of vessels through casualties and condemnation.

More complete statements as to the foregoing are made on the following pages.

## SUMMARY OF MORE URGENT NEEDS OF THE LIGHTHOUSE SERVICE.

1. Revision of pay schedules, so as to bring about a just relation according to duties and responsibilities between various branches of the Service, and particularly, new schedules with material increases of pay for certain classes who have shared but little, or not at all, in readjustments since conditions before the war; this applies particularly to the Bureau force in Washington, the technical and clerical forces in the districts, and to depot keepers.
2. Provision for replacing many of the vessels of the Lighthouse Service which have been lost or worn out in service or which will soon have to be condemned, as well as for adding reasonable vessel equipment to meet the considerable increase of the past 10 years in the aids to navigation maintained.
3. Increased maintenance appropriations to meet the continued increase in cost of supplies and labor and to enable proper repair and care of the great amount of exposed property, including vessels, under the charge of this Service.
4. Provision is greatly needed for improved depot facilities in several of the districts, particularly at or near Norfolk, Va.; Key West, Fla.; Honolulu, Hawaii; and Newport, R. I.; and additional funds are needed for the completion of the important depots at Boston, Mass., and Charleston, S. C.
5. Legislation is needed extending the retirement system in the Lighthouse Service to cases of disability incident to the work other than injury received in the line of duty, already provided for. The enactment of a general civil-service retirement law covering all persons in the Lighthouse Service not included under the present law is also strongly recommended.

More complete explanations of these and other recommendations are given later in this report.

## COOPERATION WITH NAVY AND WAR DEPARTMENTS.

The lighthouse vessels and stations which had been operated under the jurisdiction of the Navy Department during the war were returned to the jurisdiction of the Lighthouse Service July 1, 1919.

In all, 46 tenders, 4 light vessels, and 21 light stations, with their personnel, a total of 1,132 persons, had been transferred to the Navy Department during the war. This was done under the act of August 29, 1916, which authorized the President, whenever in his judgment a national emergency exists, to transfer to the service and jurisdiction of the Navy Department or of the War Department such vessels, equipment, stations, and personnel of the Lighthouse Service as he might deem to the best interests of the country. The act provided that regulations governing this duty be prescribed jointly by the Secretary of the Navy, the Secretary of War, and the Secretary of Commerce. Such regulations were issued April 11, 1917, and on the same date the President by Executive order transferred 30 lighthouse tenders to the War Department and 15 lighthouse tenders, 4 light vessels, and 21 light stations to the Navy Department, including their personnel. The tenders transferred to the War Department were subsequently transferred to the Navy Department.

The Lighthouse Service, in addition to the work done by the tenders directly under the orders of the War and Navy Departments during the war, provided facilities at various depots for the berthing of naval vessels, and at the general lighthouse depot at Tompkinsville, N. Y., provided special coaling facilities and quarters for naval detachments. Additional buoys were placed and other changes in aids to navigation were made as required. A few minor lights were extinguished and buoys removed. Diamond Shoal light vessel was sunk by a German submarine, and temporarily replaced by a gas buoy. Necessary repairs to naval patrol boats were made at various points, and various buoys, moorings, and other appurtenances were transferred to or purchased for the Navy and War Departments. The Lighthouse Service also cooperated with the Navy Department and the Treasury Department in connection with improvements in coast communication facilities by telephone and radio and in the transmission of reports received from light stations.

Because the tenders of the Lighthouse Service are particularly well equipped for certain classes of work, such as the handling of buoys, moorings, etc., and their officers are thoroughly familiar with the coast line and waters of the United States, these vessels were effectively used by the War Department in mine-planting operations and by the Navy Department in laying submarine defense nets, etc., during the war and later in removing these defenses. Upon the occasion of the return of the tenders the district commandant of the fifth naval district stated:

> The district commandant wishes to use this opportunity to express his high appreciation of the cordial cooperation of the Lighthouse Service in the solution of many problems arising during the period when they were under Navy control. The Lighthouse Service has responded quickly and efficiently to every demand made upon them by the naval district. The services of the lighthouse vessels were of immense value in the laying of submarine-defense nets and, after the armistice, in removing these nets. This was a task which would hardly be possible of accomplishment without the assistance of the lighthouse vessels.

## AIDS TO NAVIGATION.

In addition to this cooperation with the military services, the regular work of the Service in maintaining and improving aids to navigation was actively carried on during the year. This required strenuous work on the part of the whole Service, and particularly the district and vessel officers by reason of the extra duties referred to above. During the fiscal year three important light and fog-signal stations were established from special appropriations, namely: At Lorain Harbor, Ohio, at the end of the west breakwater, to mark the entrance to the harbor; at Sand Hills, Mich., to mark a dangerous locality on the south shore of Lake Superior; and at Lime Kiln, San Juan Island, Wash., to mark an important point on the route from Puget Sound to British Columbia and Alaska. These works are described on pages 773 to 777.

Three unwatched acetylene lights were established in the Caribbean Sea to mark the traffic lane between the Gulf coast of the United States and the Panama Canal through Yucatan Passage. This important maritime track lies between low coral reefs and islands in the northwestern part of the Caribbean Sea and had never hitherto been lighted. The work was done in cooperation with the Navy

Department, which furnished a gunboat to transport the working party and materials.

An unwatched acetylene light was established at Dog Island, Me.

During the fiscal year ended June 30, 1919, there was a net increase of 400 in the total number of aids to navigation maintained by the Lighthouse Service. There was an increase of 36 lights, 14 float lights, 86 minor lights, and 283 unlighted aids.

On June 30, 1919, there were maintained by the Lighthouse Service 16,075 aids to navigation, including 5,665 lights of all classes and 583 fog signals (not including 79 whistle and 245 bell buoys), of which 49 are submarine signals.

The table following gives a summary of the aids to navigation, under each class, established and discontinued during the fiscal year, and also the net increase, and the number in commission at the end of the fiscal years 1918 and 1919.

| Class. | 1919 | | | Total, June 30— | |
|---|---|---|---|---|---|
| | Established. | Discontinued. | Increase. | 1918[a] | 1919 |
| **Lighted aids:** | | | | | |
| Lights (other than minor lights) | 51 | 15 | 36 | 1,732 | 1,768 |
| Minor lights | 136 | 50 | 86 | 3,046 | 3,132 |
| Light-vessel stations | 1 | 3 | [b]2 | 52 | 50 |
| Gas buoys | 73 | 80 | [b]7 | 560 | 553 |
| Float lights | 6 | 2 | 4 | 158 | 162 |
| Total | 267 | 150 | 117 | 5,548 | 5,665 |
| **Unlighted aids:** | | | | | |
| Fog signals | 6 | 9 | [b]3 | 537 | 534 |
| Submarine signals | ........ | 2 | [b]2 | 51 | 49 |
| Whistling buoys, unlighted | ........ | 2 | [b]2 | 81 | 79 |
| Bell buoys, unlighted | 94 | 7 | 2 | 243 | 245 |
| Other buoys | 301 | 142 | 159 | 6,896 | 7,055 |
| Day beacons | 154 | 25 | 129 | 2,319 | 2,448 |
| Total | 469 | 186 | 283 | 10,127 | 10,410 |
| Grand total | 736 | 336 | 400 | 15,675 | 16,075 |

[a] Differences from statistics published in 1918 report are due to minor discrepancies in previous count.
[b] Decrease.

Improvements in aids to navigation in the Service generally have been made during the year, as follows: Twenty fixed lights were changed to flashing or occulting (including 2 light vessels); the illuminant of 4 lights was changed to incandescent oil vaper; the illuminant of 27 lights (including 5 light vessels and 2 buoys) was changed to acetylene; the illuminant of 9 lights was changed to electric incandescent.

The fog signals at seven important stations were improved by the installation of air diaphones in place of less efficient apparatus.

Considerable work was done during the fiscal year in repairing damage to aids to navigation caused by ice floes during the winter of 1917–18, especially to screw-pile structures in Chesapeake Bay and the Potomac River. Much was also done in repairing hurricane damage to aids in the Gulf of Mexico, reconstructing stations, so far as practicable, in a manner calculated to better withstand future destruction.

The mild winter of 1918–19 presented a great contrast to the severe weather of the preceding winter and permitted the removal of buoys from their stations for the winter without loss or trouble, and in some cases buoys usually removed for the winter were kept on station throughout the year, which rarely happens in north Atlantic waters.

Various special works were actively in progress during the year, embracing the establishment of important new light and fog-signal stations and lighthouse depots, improvements in systems of fixed aids and buoyage, etc. Much of this work was well advanced at the close of the year.

General repairs required for upkeep of aids to navigation and maintaining them in efficient working condition were continued during the year so far as available funds permitted, but insufficiency of funds prevented this work being done to the extent needed for proper maintenance of this large amount of important public property.

On March 18, 1919, the unwatched light at Molokini Island, Hawaii, completed eight years of service without having been extinguished. This light was the first compressed acetylene light established on the Hawaiian Islands.

An earthquake and tidal wave of considerable intensity occurred in Porto Rico and vicinity on October 11, 1918. Lighthouse property was not seriously damaged, except at Point Borinquen and Point Jiguero Light Stations, which were practically wrecked.

Damage to lighthouse property, estimated at $13,500 was sustained on December 8, 1918, by a fire at Execution Rocks Light Station, N. Y. The fog-signal engine and machinery, also the tower, oil house, and dwelling, were damaged.

## ALASKA.

During the year 36 new aids were established in Alaska. Nineteen new lights were established; 4 lights were changed from fixed to flashing; 1 gas and bell buoy was established; also 13 unlighted buoys and 3 beacons.

The total number of aids to navigation in Alaska, including lights, gas buoys, fog signals, buoys, and daymarks, in commission at the close of the fiscal year ended June 30, 1919, was 475, including 180 lights and 8 gas buoys, representing an increase of 151 lighted aids since June 30, 1910, or 408 per cent. The following table, which gives the total number of aids to navigation on June 30 of 1910, 1915, and of each succeeding year, illustrates the progress in establishing aids in the Territory:

| Aids. | 1910 | 1915 | 1916 | 1917 | 1918 | 1919 |
|---|---|---|---|---|---|---|
| Lights | 87 | 112 | 147 | 152 | 161 | 180 |
| Gas buoys |  |  |  | 7 | 7 | 8 |
| Fog signals | 9 | 10 | 11 | 11 | 11 | 11 |
| Submarine bell |  |  |  | 1 | 1 | 1 |
| Buoys | 84 | 167 | 181 | 189 | 198 | 211 |
| Daymarks | 30 | 49 | 49 | 56 | 61 | 64 |
| Total | 160 | 338 | 388 | 416 | 439 | 475 |

The act of June 12, 1917, appropriated $60,000 for establishing and improving aids to navigation in Alaskan waters. During the fiscal year 1919, eight acetylene lights and one gas and bell buoy were established with funds from these appropriations.

The sundry civil act approved July 19, 1919, appropriated $75,000 for establishing new aids to navigation and improvements of existing aids. Additional special appropriations aggregating $225,000 will be asked of Congress to continue the work of general increase of lights and buoys in Alaska, including a light and fog signal at Cape Spencer, Cross Sound, and other new aids, and improvements at existing stations.

The sundry civil act of July 1, 1918, contained an appropriation of $90,000 for a lighthouse depot with necessary equipment for this district. The site has been cleared over the area to be occupied by warehouse, shops, etc., and the construction of the wharf was about 95 per cent completed and the entire project about 35 per cent completed on June 30, 1919.

### GUANTANAMO, SAMOA, AND GUAM.

The act of July 1, 1918, appropriated $14,000 for dwellings for keepers and improvements at Guantanamo Bay, Cuba. Preparations for this work are in progress.

The aids to navigation in the outlying United States territory at Guantanamo Bay, the American Samoan Islands, and the island of Guam are maintained under the supervision of the naval commandants by means of allotments made from the appropriations for the Lighthouse Service. Reports have been received from naval officers in local charge indicating that the aids have been properly maintained, at an approximate annual expense as follows: Guantanamo, $4,555; Samoa, $872; Guam, $101.

## VESSELS FOR THE UNITED STATES LIGHTHOUSE SERVICE—URGENT NECESSITY FOR REPLACEMENT OF VESSELS WORN OUT AND DESTROYED.

### SERVICE PERFORMED BY LIGHTHOUSE VESSELS.

In the operation of this, the most extensive lighthouse service in the world, covering 47,300 miles of general coast line and rivers, there are at present employed 117 vessels, of which 54 are tenders and 63 are light vessels. The tenders are both supply ships and buoy tenders, carrying supplies and personnel to lighthouses and lightships, placing and caring for buoys, and doing construction, repair, and inspection work. They are the essential arteries of the Service, and keep up the most continuous and extensive patrol of the coasts of the United States. If anything is amiss with lightship, lighthouse, or buoy they are promptly dispatched in aid, and very frequently give succor to other vessels or persons or property in danger. The light vessels are the floating lighthouses, located in the most important positions for safeguarding shipping, and many of them on very exposed and hazardous stations off the coasts of the country. Equipped with distinctive lights, powerful fog signals, submarine bells, and radio communication, and guarding the dangerous points of the coast and the approaches to the great harbors, they are much the most indispensable of the aids to navigation.

No vessels are exposed to more severe usage than the vessels of the Lighthouse Service. The tenders are continuously on the go, handling buoys of great weight in proportion to the size of the vessel, as well as large quantities of coal and other supplies, and in working buoys must navigate close to the edges of reefs and shoals, and in waters which other vessels shun. The light vessels must remain at anchor in exposed positions off the coast during the most severe gales and hurricanes. The handling of buoys and supplies must often be done in a seaway under difficult or dangerous conditions.

### RELATION TO OTHER GOVERNMENT ACTIVITIES.

The United States is making a very large investment in shipping. The total amount authorized or appropriated by Congress for the Emergency Fleet Corporation to October 15, 1918, was $3,671,000,000, covering the purchase and construction of over 3,100 vessels, or more than double the total number of seagoing merchant vessels of the United States at the beginning of the war. The expenditures of the Navy Department for the construction of new vessels for the one fiscal year 1918 were about $450,000,000. The expenditures for vessels for the Lighthouse Service should be considered as one of the relatively small items of insurance for this great investment of the Government in shipping, as well as for all the privately owned shipping of this country and the shipping of other countries which visits our shores. The United States expends about $40,000,000 a year on river and harbor improvements, and the maintenance of the aids to navigation is indispensable to make these improvements useful to vessels.

### PRESENT CONDITION OF VESSELS AND NECESSITY FOR UPKEEP.

The useful life of a lighthouse tender is about 25 years and of a light vessel about 30 years under normal conditions. The average age of the vessels of the Lighthouse Service is at present for tenders 22 years and for light vessels 28 years, and for each class this average has increased by 3 years since 1914, owing to lack of replacement of vessels. Of the light vessels now in use 20 are more than 30 years old, and of the tenders 17 are more than 25 years old. Twelve of the light vessels are over 50 years old.

To maintain 54 tenders and 63 light vessels, with a useful life as above stated, it is evident that on an average 2 tenders and 2 light vessels must be built each year, and the recommendations and estimates submitted have yearly emphasized this fact. In the 9 years since 1910, however, but 11 tenders and 7 light vessels have been built, a total of 18, or only one-half the number of replacements necessary to maintain the Service on its former basis without allowing for any increase. However since 1910 the number of aids to navigation maintained by this Service has increased from 11,660 to 16,075, a total increase of 4,415 or 38 per cent, and three new districts, Alaska, Porto Rico, and Hawaii have been added; also the number of gas buoys maintained has increased from 225 to about 600, and the number of automatic gas shore lights has increased from 117 to about 600. All of these increases, and particularly the gas buoys and automatic shore lights, have added greatly to the work of the tenders, so that notwithstanding important economies in tender service that were effected at the reorganization in 1910, the present number of tenders, even if they were efficient modern vessels, has become inadequate to maintain the Service as required in the interest of navigation. Many of the present tenders are, moreover, not capable of giving the efficient work required, because of their type (4 of them are side-wheel vessels built 36 or more years ago) and their not being designed to handle the heavy gas buoys which have been developed since they were built, their age (some of them are not sufficiently seaworthy to be sent on outside work), and the loss of time due to necessity for frequent repairs. Many of the present lightships are not suitable to be placed on exposed stations. The cost of repairs and overhaul becomes so heavy that it is not economical to keep in commission vessels after they have reached a reasonable limit of usefulness. The effect of continuing the use of these old vessels is often a greatly diminished output of work with the same or greater cost of operation and upkeep. Of more importance than the question of efficient and economical operation, however, is that of safeguarding life. Both lighthouse tenders and lightships are engaged on hazardous duty, and their officers and crews should not be required to serve on vessels which have passed a reasonable limit of usefulness, nor can the Lighthouse Service properly perform its part in the safeguarding of life and property on the navigable waters of this country without necessary vessel equipment.

## RECENT CONDITIONS AFFECTING VESSELS.

The deficiency of vessels in the Lighthouse Service has been much accentuated by an unusual number of casualties in the last year and a half. Since January, 1918, Diamond Shoal Light Vessel has been sunk on station by a German submarine; Cornfield Point Light Vessel has been run into by a barge and sunk on station; Cross Rip Light Vessel has been destroyed by the ice; Thirty-five Foot Channel Light Vessel has been destroyed by fire at a contractor's dock; and Bush Bluff Light Vessel and the tender *Gardenia* have been condemned as worn out and not worth repair.

All of the tenders of the Lighthouse Service, excepting one, were by order of the President placed on duty with the Navy Department during the period of the war, and during this time from April, 1917, to July, 1919, have been performing various duties for that department in addition to doing their regular lighthouse work Some of this naval duty, such as the handling of protection nets, has been strenuous work for these vessels. As a result of this, as well as the shortage of tenders and the difficulty of effecting repairs under war conditions, there has unavoidably been an unusual deterioration of vessels. Experience of the last two years has proven that the lighthouse vessels are of especial value in time of national emergency, which is an additional reason for the proper maintenance of these vessels. The tenders are the best available type of small vessel for handling moorings, nets, etc., and the light vessels are valuable signal stations at strategic points off the coast.

No appropriations for lighthouse vessels have been made since the act of June 12, 1917, or for more than two years. Of the appropriations made at that time that of $150,000 for a tender for the third district has been impracticable to use, as the lowest bid received for the vessel was $333,800, and, on readvertising, $357,250, not including equipping the vessel. The appropriation of June 12, 1917, of $150,000 intended for two small light vessels for the Great Lakes was barely sufficient to contract for one such vessel. War conditions in the shipbuilding industry render it impossible to use several appropriations or balances of appropriations, which are quite insufficient under present shipbuilding costs. Under the appropriation of June 12, 1917, of $130,000, for a light vessel, recent bids were $297,000, $396,700, and $496,000 for the bare vessel, without outfit.

Due to war conditions and insufficiency of appropriations, no new contracts for large lighthouse tenders have been made since September, 1915, and since June, 1916, only one light vessel has been contracted for.

Very thorough investigation has been made as to the possibility of obtaining vessels suitable for work of the Lighthouse Service from the Shipping Board or from vessels no longer needed by the Navy on account of the cessation of the war. It was found that the Shipping Board had no vessels in any way suitable. From the Navy two small vessels have been transferred which will be used for shoal-water tender work, but they will be of but limited usefulness. Lighthouse tenders and light vessels are both vessels of unusual requirements, and it is impracticable to meet the special needs of this work by adapting vessels built for other purposes.

## ESSENTIAL PROGRAM FOR MAINTENANCE OF VESSELS FOR LIGHTHOUSE SERVICE.

From careful estimates and examinations as to the condition and further serviceability of vessels of the Lighthouse Service, it is found that within the next five years 18 light vessels and 10 tenders, as shown in the following list, should be replaced with vessels of the types indicated, and one light vessel should be built for new station. As it will require under favorable conditions from two to three years after appropriation is made before vessels are available for service, funds should be provided now for 17 of these vessels most urgently needed, in addition to 3 vessels for which estimates have been heretofore submitted, two to be built under the authorization of June 20, 1918, and one to replace Diamond Shoal Light Vessel.

The vessels for which appropriation should be made now are the following, with estimated cost:

| | Estimated cost. |
|---|---|
| To replace Diamond Shoal Light Vessel: | |
| Light vessel to replace No. 71, Diamond Shoal, fifth district, class 1.. | $450,000 |
| To be built under authorization of June 20, 1918: | |
| Tender to replace Jessamine, fifth district, class B.................... | 400,000 |
| Tender to replace Gardenia, third district, class B.................... | 400,000 |
| | 800,000 |
| Additional vessels, authorization of which is now necessary: | |
| Light vessel for Barnegat, N. J. (new station), class 2................ | 335,000 |
| Light vessel to replace No. 51, Relief, third district, class 2.......... | 335,000 |
| Tender to replace John Rodgers, third district, class B............... | 400,000 |
| Tender to replace Holly, fifth district, class B........................ | 400,000 |
| Tender to replace Mistletoe, third district, class B.................. | 400,000 |
| Light vessel to replace No. 43, Relief, eighth district, class 2......... | 335,000 |
| Light vessel to replace No. 20, Cross Rip, Mass., second district, class 2. | 335,000 |
| Light vessel to replace No. 3, Handkerchief, Mass., second district, class 2.......................................................... | 335,000 |
| Tender to replace Goldenrod, fourteenth district, inland rivers........ | 100,000 |

| Additional vessels, authorization of which is now necessary—Continued. | Estimated cost. |
|---|---|
| Light vessel to replace No. 11, Scotland, N. J., third district, class 2 | $335,000 |
| Light vessel to replace No. 44, Northeast End, N. J., third district, class 2 | 335,000 |
| Light vessel to replace No. 68, Fire Island, N. Y., third district, class 2 | 335,000 |
| Light vessel to replace No. 69, Overfalls, Del., third district, class 2 | 335,000 |
| Light vessel to replace No. 46, Tail of Horseshoe, Va., fifth district, class 2 | 335,000 |
| Light vessel to replace No. 56, North Manitou, Mich., twelfth district, class 3 | 160,000 |
| Light vessel to replace No. 57, Grays Reef, Mich., twelfth district, class 3 | 160,000 |
| Light vessel to replace No. 60, Eleven-Foot Shoal, Mich., twelfth district, class 3 | 160,000 |
| Total | 5,130,000 |

On May 15, 1919, in a letter to the Speaker of the House of Representatives in connection with legislation affecting the Lighthouse Service, this Department requested that a provision be included authorizing the "Constructing or purchasing and equipping lighthouse tenders and light vessels for the Lighthouse Service, $5,000,000." This, with tne estimates pending, would provide for the above immediate necessities. The large number of new vessels required now is directly due to the conditions of recent years which have prevented replacement of vessels in this Service at a proper rate. The situation is not unprecedented, however, for in the sundry civil act of March 4, 1907, appropriations were made for building or completing 21 light vessels and tenders, and an amount of $2,180,000 was included for vessels. For 10 of these vessels there had also been previous appropriations.

The building of vessels for this Service should not be deferred on account of present shipbuilding costs. The expense will undoubtedly be materially higher than the costs a few years back, but there is no likelihood of any early reduction in building costs. This replacement of vessels has already been so repeatedly deferred on account of war conditions that the fleet of this Service is in a seriously depreciated condition, which can not safely be permitted to continue. The costs of these vessels, on a tonnage basis, will be higher than costs announced by the Shipping Board for building fabricated ships for these reasons: The lighthouse vessels are small and of a special type, will be built in small numbers, and must be unusually staunch for their size. Also, the Shipping Board per-ton price does not include investment and depreciation of plant, which, of course, every contractor must include in bidding on work. The Lighthouse Service can, however, undoubtedly obtain more favorable bids by constructing, as is proposed, several vessels of one type at one time. The following are some comparisons as to the costs of vessels of small size and special types, somewhat comparable with the required vessels for the Lighthouse Service. In January, 1919, the Coast Guard contracted for building five cutters at $687,000 each. These vessels are of 1,200 tons construction weight, or will cost $572 per ton. The tender *Cedar*, completed in 1917, according to sworn statements of the contractors, cost $448 per ton construction weight to build; since 1917 there has been material increase in cost of shipbuilding. The lowest bids, received within the past year, were $565 per ton for the tender *Oak*, and $539 per ton for a vessel for the Coast

Survey. The recent contract price for steel barges for the upper Mississippi River was at $401 per ton; these barges are of much simpler construction than seagoing vessels. The above comparisons are on the basis of construction weight, which is the actual weight of vessel without supplies or load.

*List of lighthouse vessels requiring replacement within the next five years (not allowing for any losses of vessels).*

| Vessel. | Age. | Remarks. | Replace by— | Necessary to build. |
|---|---|---|---|---|
| LIGHT VESSELS. | *Yrs.* | | | |
| No. 71, Diamond Shoal. | ...... | Sunk by submarine. | New ship | Class 1, light vessel. |
| No. 51, Relief | ...... | Sunk by collision | do | Class 2, light vessel. |
| No. 55, Lansing Shoal | 28 | Worn out | Light vessel No. 99 (building). | |
| No. 43, Relief | 38 | do | New ship | Do. |
| No. 20, Cross Rip | 52 | do | do | Do. |
| No. 62, Bar Point | 26 | do | Canadians will provide | |
| No. 61, Huron | 26 | do | Light vessel No. 103 (building). | |
| No. 3, Handkerchief | 67 | do | New ship | Class 2, light vessel. |
| No. 11, Scotland | 66 | do | do | Do. |
| No. 44, Northeast End. | 37 | do | do | Do. |
| No. 68, Fire Island | 22 | do | do | Do. |
| No. 69, Overfalls | 22 | Less exposed station. | do | Do. |
| No. 46, Tail of Horseshoe. | 32 | Worn out | do | Do. |
| No. 56, Manitou | 28 | do | do | Class 3. |
| No. 57, Grays Reef | 28 | do | do | Do. |
| No. 60, Eleven-Foot Shoal. | 26 | do | do | Do. |
| No. 73, Pollock Rip Slue. | 18 | Less exposed station. | do | Class 2, light vessel. |
| No. 48, Cornfield | 28 | Worn out | Light vessel No. 73 | |
| No. 34, Charleston | 55 | do | New ship | Class 1, light vessel. |
| No. 70, San Francisco | 22 | do | do | Do. |
| No. 39, Brenton Reef | 44 | do | Light vessel No. 69 | |
| TENDERS. | | | | |
| Jessamine | 38 | Worn out | New tender | Class B, tender. |
| Gardenia | 40 | Condemned | do | Do. |
| John Rodgers | 36 | Worn out | do | Do. |
| Holly | 38 | do | do | Do. |
| Mistletoe | 47 | do | do | Do. |
| Goldenrod | 31 | do | do | Class special. |
| Arbutus | 40 | do | do | Class B, tender. |
| Lilac | 27 | do | do | Class A, tender. |
| Snowdrop | 23 | do | do | Class B, tender. |
| Myrtle | 47 | do | do | Do. |

*Additional vessels required for new station.*

| | |
|---|---|
| Light vessel, Barnegat, N. J | Class 2 |
| Tender for Alaska | Class B |

*General types of vessels proposed.*

| Vessel. | Length. | Construction weight. | | Estimated cost. |
|---|---|---|---|---|
| | | Tons. | Cost per ton. | |
| LIGHT VESSELS. | *Feet.* | | | |
| Class 1, most exposed stations | 147 | 615 | $650 | $400,000 |
| Class 2, exposed stations | 135 | 515 | 650 | 335,000 |
| Class 3, Great Lakes stations | 96 | 240 | 650 | 160,000 |
| TENDERS. | | | | |
| Class A, seagoing | 190 | 1,000 | 650 | 650,000 |
| Class B, coastwise | 170 | 620 | 650 | 400,000 |
| Class special, inland rivers | 150 | 250 | 400 | 100,000 |

## ADMINISTRATION.

The pay question is a very serious one throughout the Lighthouse Service. The bonus increases made by Congress have proved inadequate to meet the difficulty, and consequently do not satisfy the personnel. This bonus averages about 10 per cent to 15 per cent over prewar salaries, which is very much less than the well-authenticated figures as to the increased cost of living during the same period. Discontent is increased by the fact that in certain classes of occupation, both without and within the Government service, increases of compensation have been made, equaling or exceeding the increased cost of living, and that in the organization of new Government activities much higher scales of compensation have been set. Within the Lighthouse Service itself serious inequalities have arisen through the inability to extend throughout the Service the same proportionate increase made in certain occupations because of the action of outside Government boards. Serious discrepancies result, which the estimates submitted will endeavor to correct. The complaints of the actual difficulty of living decently and supporting a family on the present compensation in some grades are known to be well founded. Such adjustments as possible to meet the situation have been made.

Much difficulty has been had in maintaining sufficient and efficient complements on vessels of the Lighthouse Service, notwithstanding increases of pay scales. Great credit is due to many of the officers of these vessels for their loyal work and standing by the Service under these difficult conditions.

A revised schedule of pay for keepers of lighthouses was put in effect on November 1, 1918, upon the appropriation by Congress of funds for carrying out the provisions of the act of June 20, 1918, increasing the average pay of keepers from $600 to $840 per annum.

The general organization of the Service remained unchanged during the fiscal year.

The appropriations for the maintenance of the Lighthouse Service for the fiscal year 1920 were $1,054,600 less than the estimates submitted, and additional funds will be necessary for even the minimum maintenance of the Service during this fiscal year; for this deficiency estimates will be submitted. During the last fiscal year $774,000 was transferred from Navy Department appropriations to make good deficiencies in the maintenance of the Lighthouse Service, but as the vessels and stations were transferred back on July 1, 1919, funds will not be available from the similar provisions in the Naval appropriation act this year.

The Department approved regulations for the distribution of Lighthouse Service publications on a sales basis, pursuant to act of Congress of June 20, 1918, and this was put in effect January 1, 1919. Sales agencies have been established at the principal ports, and include marine dealers and various Government officers. Returns of sales are made to the Superintendent of Documents, Washington, D. C., who supplies agents with the necessary copies of the publication and accounts for the proceeds.

Systematic inspections have been continued in the various lighthouse districts of the technical work, business methods, and property accounts.

In order to take advantage of local markets, the Department authorized the sale of such empty oil cans as may accumulate at light stations, etc., without the usual method of condemnation and sale. This has proved advantageous to the Government.

The President on February 25,, 1919, signed a proclamation reserving for lighthouse purposes the southwest cay of Serrano Banks, also such suitable portions of Quito Sueno Banks, located in the western part of the Caribbean Sea, as the Department may desire, also Roncador Cay, by proclamation, signed June 5, 1919.

On April 8, 1919, and June 2, 1919, respectively, the President, by proclamation, restored to the control of the government of Hawaii property of the Lighthouse Service no longer needed for lighthouse purposes, situated at McGregor Point, on the island of Maui, containing about 4.2 acres, and 256 square feet at Honolulu, Hawaii.

On April 16, 1919, the President, by Executive order, reserved for lighthouse purposes three unsurveyed islands in the Straits of St. Mary, an arm of Lake Huron, known as Squaw Island and Pipe Island Twins.

On April 22, 1919, the President, by Executive order, reserved for lighthouse purposes fractional sec. 32, T. 15 S., R. 15 W., Louisiana meridian, La., containing 45.56 acres. The reservation is located at Sabine Pass, La.

## ENGINEERING AND CONSTRUCTION.

The most important items of construction work completed during the fiscal year were the new light and fog-signal stations at Lorain Harbor, Ohio; Sand Hills, Mich.; and Lime Kiln, San Juan Island, Wash. Three acetylene lights were established in the Caribbean Sea. An unwatched acetylene light was established at Dog Island, Me. Eight acetylene lights were established in Alaska. Riprap was placed as a protection against ice at various light stations on Chesapeake Bay and Potomac River. These works are described on pages 772 to 777.

Improvements consisting of electric lighting installation and electric welding equipment at Woods Hole (Mass.) Lighthouse Depot were completed.

Other important works in progress at the close of the fiscal year included: Riprap at Duxbury Pier and Scituate Breakwater Light Station, Mass.; aids to navigation, Hudson River, N. Y.; aids to navigation, East River, N. Y., Great Salt Pond Light Station, R. I. improvements; Hunts Point, N. Y., light and fog signal; Staten Island Lighthouse Depot, N. Y., rebuilding wharves, coal sheds, and other improvements; Ambrose Channel, N. Y., improving buoyage; aids to navigation, Delaware River, Pa. and Del.; Joe Flogger Shoal, Del., improving aids; Cape Charles City, Va., improving lights and fog signals; Chesapeake Bay, Md. and Va., improving aids to navigation; repairing ice and storm damage, Chesapeake Bay and Potomac River. Improving buoyage, fifth district; aids to navigation, St. Johns River, Fla.; repairing and rebuilding aids to navigation damaged by storm and ice, Atlantic coast; repairing and rebuilding aids to navigation, Florida Reefs, Fla.; repairing and rebuilding aids to navigation damaged by hurricane, Gulf of Mexico and Mississippi River below New Orleans, La.; improving aids to navigation Conneaut Harbor, Ohio; establishing aids to navigation, Huron Harbor, Ohio; improving aids to navigation, Fairport Harbor, Ohio; aids to navigation, Keweenaw Waterway, Mich.; aids to navigation, St. Marys River, Mich.; repairing Spectacle Reef Light Station, Mich.; improvements at Detroit Lighthouse Depot, Mich.; improving aids to navigation, Detroit River, Mich.; establishing a light and fog signal at White Shoal, Mich.; rebuilding Chicago Harbor Light Station, Ill.; aids to navigation, Indiana Harbor, Ind.; improving aids to navigation, Alaska; establishing a light-house depot at Ketchikan, Alaska; improving aids to navigation, Puget Sound, Wash.; improving aids to navigation Washington and Oregon; aids to navigation, Pearl Harbor, Hawaii. These works are described on pages 738 to 745.

## IMPROVEMENT OF APPARATUS AND EQUIPMENT.

Radio equipment was installed on 32 light vessels and on 16 tenders during the fiscal year. At the end of the fiscal year 40 light vessels and 23 tenders in all had been equipped with radio installations.

The installation of telephones at light stations was continued during the year. This work was done by the United States Coast Guard under an appropriation made by act of June 12, 1917, to develop coastal communications, including connections with important light stations. On June 30, 1919, there were 139 light stations so connected.

Experiments and tests continued during the fiscal year with various devices and equipment used in lighthouse work have resulted in developing improvements in the interests of efficiency and economy in the service. Among these may be mentioned improvements in diaphone installations, resulting in simplicity of operation, reduced space required for machinery, and lowered initial cost. A new type of metal buoy was developed for use in defining shoal-water channels, being an improvement over wooden spar buoys which are less conspicuous as aids and more expensive to maintain under ice conditions. The stability of the type L gas and bell buoy, where moored in the exposed waters of Alaska and likely to be weighted with ice, was improved.

An experiment carried out to determine whether a bell buoy can be arranged to give a definite characteristic has been successfully accomplished by the installation on a gas buoy of a bell operated by compressed carbon-dioxide gas in storage tanks. The tanks are located in one of the pockets of the buoy, and the bell sounds continuously one stroke every 15 seconds. The buoys successfully replaced a light vessel.

On account of immunity from wood-boring worms the use of palmetto piles has been extended in southern waters.

An improved device for fastening moorings to buoys in the upper Mississippi River was tested and proved satisfactory.

Investigation of the use of radio for fog-signal purposes was interrupted by war activities. Recently the Navy Department has established a number of radio-compass stations equipped to furnish bearings to vessels. Further investigation of the possibilities of radio signals for aiding vessels in fog is in progress.

An improved method of making concrete sinkers for buoys in one of the river districts was adopted with satisfactory results.

## PERSONNEL.

On June 30, 1919, there were 5,964 persons employed in the Lighthouse Service, including 125 technical, 156 clerical, and 5,683 employees connected with light stations, vessels, and depots. This Service is charged with the maintenance of aids to navigation along 47,300 statute miles of general coast line and river channel.

The following table gives the number of employees (all authorized employees, including some vacancies) of the Lighthouse Service at the end of the fiscal year and a comparison of the totals with those for the previous fiscal year:

EMPLOYEES IN THE LIGHTHOUSE SERVICE ON JUNE 30, 1919.

| District. | Superintendents, engineering force, draftsmen, aids, appointed foremen, and mechanicians. | Clerks, messengers, janitors, and office laborers. | Depot keepers and assistants, including laborers. | Light keepers and assistants. | Laborers and laborers in charge of lights (appropriation "Salaries, keepers of lighthouses"). | Laborers in charge of post lights and buoys (appropriation "General expenses"). | Custodians of reservations. | Officers and crews on tenders and light vessels. | Field force for construction and repair (registered). | Field force for construction and repair (unregistered). | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Bureau | 17 | 27 | | | | | | | | | 44 |
| First | 3 | 6 | 1 | 114 | 3 | | | 71 | 9 | 6 | 213 |
| Second | 4 | 7 | 2 | 79 | 11 | | 2 | 220 | 6 | 11 | 342 |
| Third | 21 | 34 | 16 | 179 | 32 | 54 | 2 | 285 | 179 | 45 | 847 |
| Fourth | 6 | 5 | 3 | 57 | 3 | 4 | 6 | 32 | 5 | 4 | 125 |
| Fifth | 11 | 10 | 45 | 165 | 94 | 20 | | 287 | 4 | 11 | 647 |
| Sixth | 5 | 7 | 2 | 55 | 10 | 25 | | 140 | 12 | 10 | 266 |
| Seventh | 2 | 3 | 1 | 41 | 1 | 7 | | 37 | 5 | 10 | 107 |
| Eighth | 7 | 9 | 16 | 110 | 33 | 35 | | 121 | 8 | 24 | 363 |
| Ninth | 3 | 5 | 1 | 41 | 10 | | | 24 | 4 | 3 | 91 |
| Tenth | 7 | 5 | 2 | 69 | 1 | | 1 | 28 | 5 | 20 | 138 |
| Eleventh | 9 | 6 | 6 | 161 | 9 | 2 | 2 | 113 | 13 | 46 | 367 |
| Twelfth | 9 | 6 | 5 | 156 | 17 | 2 | | 98 | 5 | 8 | 306 |
| Thirteenth | 1 | 2 | | | | 309 | | 19 | | | 331 |
| Fourteenth | 1 | 2 | | | | 536 | | | | | 539 |
| Fifteenth | 1 | 2 | | | | 364 | | 20 | | | 387 |
| Sixteenth | 5 | 5 | 1 | 36 | | 27 | | 53 | | 25 | 152 |
| Seventeenth | 6 | 6 | 5 | 81 | 15 | 123 | | 130 | 6 | 6 | 378 |
| Eighteenth | 6 | 6 | 7 | 106 | 13 | 5 | | 94 | 4 | 10 | 251 |
| Nineteenth | 4 | 3 | 1 | 27 | 2 | | | 30 | | 6 | 73 |
| Total, 1919 | 128 | 156 | 114 | 1,477 | 254 | 1,513 | 13 | 1,802 | 265 | 245 | 5,967 |
| Total, 1918 | 120 | 150 | 107 | 1,457 | 256 | 1,524 | 14 | 1,736 | 276 | 259 | 5,899 |
| Increase | 8 | 6 | 7 | 20 | | | | 66 | | | 68 |
| Decrease | | | | | 2 | 11 | 1 | | 11 | 14 | |

The retirement system for the field service of the Lighthouse Service was put in effect upon the appropriation by Congress of the necessary funds by act approved November 4, 1918. By the same act the retirement law was amended to the extent that the provisions of the law do not apply to persons in the field service whose duties do not require substantially all their time. The number of retirements up to June 30, 1919, was 100, including 88 persons 70 years and over. The effect of the retirement system has been very advantageous both to the Service and the personnel, and at a moderate expense.

Up to June 30, 1919, a total of 152 persons from the Lighthouse Service, exclusive of those transferred by Executive order, had entered the Army or Navy, making with those transferred a grand total of 1,284 employees who have entered the military services, or 23 per cent of the normal force of the Lighthouse Service.

The employees of the Lighthouse Service subscribed liberally to the fifth Victory Liberty Loan, as well as to previous Liberty Loans. They have also liberally purchased War Saving Stamps and displayed commendable activity in the food-conservation campaigns.

The Comptroller of the Treasury has made a decision that lighthouse employees who have been transferred to the service and jurisdiction of the Navy Department by Executive order are not entitled upon discharge to the $60 bonus provided by act of February 24, 1919, for persons serving in the military or naval service of the United States during the war.

The Acting Secretary of the Treasury on March 22, 1919, advised that light keepers and officers and crews of vessels, after being retired, are not entitled to the benefits of the Public Health Service free of charge.

During the fiscal year services in saving life and property were rendered and acts of heroism performed by employees of the Lighthouse Service on 111 occasions. Many of these acts were considered especially meritorious and the employees were individually commended by the Secretary of the Department. A list in detail of services rendered is given on pages 747 to 751.

Ralph H. Goddard, superintendent of the second lighthouse district, died March 4, 1919. Mr. Goddard entered the Lighthouse Service in 1887 and served continuously until his death. His record is a creditable one, he having worked his way up solely on personal merit through the various grades of employment on lighthouse vessels and in the supply department at the general lighthouse depot. In June, 1912, he was placed in charge of the second lighthouse district, holding this position at the time of his death.

The keeper and one of the assistant keepers at Sand Island Light Station, Ala., were missing when the station was visited in January, 1919, to investigate a report of the extinguishment of the light. Nothing has been learned as to the fate of these two men, but it is supposed that they lost their lives by the capsizing of their launch while going ashore for the purpose of taking to the station another assistant keeper who had been ashore on leave.

## COST-KEEPING SYSTEM AND RESULTS.

The system of cost keeping for the service was modified, reducing the amount of detail work required in district offices without sacrificing the more essential data furnished. This modification was necessary in order that other important work, increased by the extra work due to war conditions, might be kept up.

A generalized summary of costs for the fiscal year ended June 30, 1919, follows, as derived from this cost-keeping system. The figures given are inclusive of amounts paid employees from the appropriation increase of compensation, Department of Commerce. Notwithstanding the most careful and painstaking efforts to economize in every direction, the continued extraordinary advance in the price of labor and materials is clearly shown in the increased cost reported for practically all features.

## SUMMARY OF COSTS, LIGHTHOUSE SERVICE, FISCAL YEAR ENDED JUNE 30, 1919.

[Amounts are stated to nearest even dollar, causing occasional minor discrepancies in totals. Difference from total expenditures reported elsewhere is due to inclusion of Bureau salaries, printing expenses, and adjustment of inventories of articles furnished from stock.]

### TOTAL COSTS OF PRINCIPAL FEATURES.

| Feature. | Maintenance expenses. | | | | | Betterment expenses. | | | | | Grand total. | Per cent. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Salaries. | Subsistence. | General supplies. | Incidental expenses. | Total. | Repairs and improvements. | | | New works. | Total. | | |
| | | | | | | Hired labor. | Materials. | Contract work. | | | | |
| Administration [a] | $357,350 | $24,723 | $25,057 | $5,411 | $412,541 | ........ | ........ | ........ | ........ | ........ | $412,541 | 5 |
| Distributive charges[b] | 1,209,614 | 251,746 | 700,698 | 45,483 | 2,207,541 | $70,811 | $98,582 | $136,224 | $134,466 | $440,083 | 2,647,624 | 35 |
| Aids to navigation [c] | 2,160,367 | 358,353 | 686,304 | 16,010 | 3,221,034 | 152,689 | 295,181 | 163,438 | 698,689 | 1,309,997 | 4,531,031 | 60 |
| Total | 3,727,331 | 634,822 | 1,412,059 | 66,904 | 5,841,116 | 223,500 | 393,763 | 299,662 | 833,155 | 1,750,080 | 7,591,196 | 100 |

### TOTAL COSTS OF DETAILED FEATURES.

| Feature. | Salaries. | Subsistence. | General supplies. | Incidental expenses. | Total. | Hired labor. | Materials. | Contract work. | New works. | Total. | Grand total. | Per cent. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Offices | $357,350 | $24,723 | $53,704 | $5,411 | $441,188 | ........ | ........ | ........ | ........ | ........ | $441,188 | 6 |
| Depots | 225,789 | ........ | 141,298 | 24,363 | 391,450 | $24,129 | $26,761 | $7,027 | $133,659 | $191,576 | 583,026 | 8 |
| Tenders: | | | | | | | | | | | | |
| Large | 231,735 | 60,485 | 186,065 | 4,895 | 483,180 | 6,345 | 10,749 | 29,998 | 250 | 47,342 | 530,522 | 7 |
| Medium | 681,006 | 174,741 | 308,778 | 15,136 | 1,179,661 | 31,838 | 41,413 | 74,917 | 552 | 148,720 | 1,328,381 | 17 |
| Small | 71,083 | 16,520 | 35,910 | 1,089 | 124,602 | 8,490 | 19,659 | 24,282 | 5 | 52,445 | 177,047 | 2 |
| Total | 983,824 | 251,746 | 530,753 | 21,120 | 1,787,443 | 46,682 | 71,821 | 129,197 | 807 | 248,507 | 2,035,950 | 26 |
| Light vessels: | | | | | | | | | | | | |
| Exposed | 265,521 | 53,225 | 63,632 | 2,914 | 385,292 | 5,835 | 22,359 | 65,539 | ........ | 93,733 | 479,026 | 6 |
| Moderately exposed | 169,419 | 34,051 | 26,478 | 710 | 230,658 | 11,979 | 28,003 | 35,917 | ........ | 75,899 | 306,557 | 4 |
| Relief | 87,337 | 19,325 | 21,131 | 468 | 128,261 | 2,951 | 21,541 | 18,163 | ........ | 42,655 | 170,916 | 2 |
| Lakes | 68,503 | 18,614 | 11,675 | 389 | 99,181 | 2,930 | 2,980 | 1,405 | 19,292 | 26,607 | 125,788 | 2 |
| Total | 590,780 | 125,214 | 122,916 | 4,481 | 843,392 | 23,695 | 74,883 | 121,024 | 19,292 | 238,894 | 1,082,287 | 14 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Light stations: | | | | | | | | | | | | |
| Primary seacoast and lake lights | 361,193 | 71,717 | 94,438 | 4,244 | 531,592 | 21,350 | 28,070 | 6,431 | 77,517 | 133,368 | 664,960 | 9 |
| All other lights except post lights | 931,090 | 161,422 | 213,038 | 5,102 | 1,310,652 | 86,573 | 164,623 | 30,304 | 515,257 | 796,757 | 2,107,409 | 28 |
| Post lights | 243,565 | ........... | 34,150 | 2,183 | 279,898 | 2,147 | 8,437 | 785 | 12,105 | 23,474 | 303,372 | 4 |
| Day marks and spindles | 57 | ........... | 440 | ........... | 497 | 1,359 | 1,689 | 1,193 | 1,101 | 5,342 | 5,839 | ........... |
| Total | 1,535,905 | 233,139 | 342,066 | 11,529 | 2,122,639 | 111,429 | 202,819 | 38,713 | 605,980 | 958,941 | 3,081,580 | 41 |
| Buoys | 33,681 | ........... | 221,322 | ........... | 255,003 | 17,565 | 17,479 | 3,701 | 73,417 | 112,162 | 367,165 | 5 |
| Grand total | 3,727,331 | 634,822 | 1,412,059 | 66,904 | 5,841,116 | 223,500 | 393,763 | 299,662 | 833,155 | 1,750,080 | 7,591,196 | 100 |

## AVERAGE COST OF SELECTED FEATURES.

| Average cost of— | Salaries. | Subsistence. | General supplies. | Incidental expenses. | Total maintenance. | Repairs and improvements. | Total cost. |
|---|---|---|---|---|---|---|---|
| District office, exclusive of third | $13,840 | $449 | $432 | $296 | $15,017 | ........... | $15,017 |
| District depot, exclusive of third | 9,332 | ........... | 2,518 | 1,057 | 12,907 | $2,572 | 15,479 |
| Large tender, Pacific | 31,352 | 8,373 | 29,310 | 307 | 69,341 | 2,435 | 71,776 |
| Large tender, Atlantic | 31,927 | 8,196 | 13,966 | 785 | 54,873 | 8,272 | 63,144 |
| Medium tender | 23,424 | 5,998 | 9,567 | 489 | 39,477 | 4,218 | 43,695 |
| Exposed light vessel | 13,178 | 2,640 | 3,174 | 142 | 19,134 | 4,677 | 23,811 |
| Moderately exposed light vessel | 8,782 | 1,775 | 1,447 | 35 | 12,040 | 3,986 | 16,026 |
| Lake light vessel | 5,269 | 1,431 | 898 | 30 | 7,629 | 563 | 8,192 |
| Primary seacoast light station | 2,474 | 491 | 646 | 29 | 3,640 | 382 | 4,024 |
| Other light station (except post lights) | 432 | 80 | 99 | 2 | 613 | 132 | 744 |
| Post light, river district | 91 | ........... | 6 | 1 | 98 | 1 | 99 |
| Post light, other district | 100 | ........... | 28 | 1 | 129 | 12 | 141 |

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[a] Includes offices, except expenses of publications.

[b] Includes depots and tenders; also item excepted above, charged to supplies.

[c] Includes light vessels, light stations, minor fixed aids, and buoys.

## APPROPRIATIONS AND EXPENDITURES.

The appropriations for the maintenance of the Lighthouse Service for the fiscal year 1920 were $6,690,430, being $255,568 in excess of those for the preceding fiscal year and include $45,000 for retired pay. These appropriations were $1,054,600 less than the estimates submitted. The appropriations for special works made for the fiscal year 1920 amounted to $354,400.

On October 1, 1918, an allotment of $100,000 was made from the appropriation for national security and defense for establishing necessary lights in the Caribbean Sea.

The average appropriations for special works for the 10 preceding years, 1910 to 1919, inclusive, amounted to $577,668.

The detailed estimates for the fiscal year 1921 are given on page 69. The total amount for general maintenance is $1,694,238.40 more than the appropriation for the present year. Particular attention is again invited to the urgent need of the Lighthouse Service for additional funds. The increase in the cost of all materials has continued, salaries and wages have been or must be advanced, and in order that the Service may be maintained at a proper standard of efficiency a corresponding increase in its appropriations is necessary. The Bureau desires to lay special stress on this matter, and on page 702 includes a more detailed statement with reference to pay.

Increases are urgently needed in the pay scale of the Bureau of Lighthouses in Washington, and it is understood this general subject will be considered by the Joint Commission on the Reclassification of Salaries.

Estimates for 22 special works have been submitted, aggregating $7,989,500 considering only group 1, of which items amounting to $1,423,000 are authorized by law. This estimate is $7,635,100 more than the appropriation for special works for the preceding year, and includes a number of important works for which estimates were submitted last year, but which were not included in the appropriations. The estimates include 6 new lighthouse tenders, 14 new light vessels, 4 new lighthouse depots, 3 items for establishing or improving aids in general localities, 5 items for improvements of harbor or channel lights and other aids, 2 items for establishing or completing light and fog-signal stations, and 4 items for improvement of lighthouse depots.

In selecting and submitting estimates for these special works believed to be most important, there were considered estimates submitted by officers in the various districts and others for new lighthouse and ship construction aggregating about $9,920,000. Many items not included in the estimates for this year are thought to be meritorious, and the more important of them are included in group 2 of the estimates for special works, submitted for consideration as the resources of the Government permit them to be taken up. Explanation of the necessity for each of the items of special works is included with the estimates.

The tables following give comparisons of appropriations and expenditures for the Lighthouse Service, beginning with the fiscal year 1916 and including the estimates for 1921.

### APPROPRIATIONS, LIGHTHOUSE SERVICE, FISCAL YEARS 1916–1920, WITH ESTIMATES FOR 1921.

[The salaries and allowances of officers of the Army on duty with the Lighthouse Service are not included in this table.]

| Item. | Appropriations. | | | | | Estimates. |
|---|---|---|---|---|---|---|
| | 1916 | 1917 | 1918 | 1919 | 1920 | 1921 |
| **MAINTENANCE.** | | | | | | |
| Salaries, Bureau of Lighthouses | $64,030 | $64,030 | $64,030 | $65,430 | $65,430 | $79,668.40 |
| Salaries of keepers of lighthouses | 940,000 | 940,000 | 940,000 | 1,194,432 | 1,300,000 | 1,330,000.00 |
| General expenses, Lighthouse Service | 2,775,000 | 2,790,000 | 2,850,000 | 3,500,000 | 3,500,000 | 4,300,000.00 |
| Salaries, lighthouse vessels | 1,010,000 | 1,070,000 | 1,104,650 | 1,265,000 | 1,400,000 | 2,100,000.00 |
| Salaries, Lighthouse Service | 375,000 | 375,000 | 380,000 | 380,000 | 380,000 | 490,000.00 |
| Retired pay, Lighthouse Service | | | | 30,000 | 45,000 | 85,000.00 |
| Total for maintenance | 5,164,030 | 5,239,030 | 5,338,680 | 6,434,862 | 6,690,430 | 8,384,668.40 |
| Unexpended balances (obligations estimated) | 47,171 | 67,377 | 14,100 | 66,283 | | |
| **SPECIAL WORK.** | | | | | | |
| New light and fog-signal stations | | 193,000 | 155,000 | 80,000 | 6,400 | 169,600.00 |
| Light vessels | | | 280,000 | | | 4,150,000.00 |
| Lighthouse tenders | 250,000 | 20,000 | 210,000 | | | 2,060,000.00 |
| Keepers' dwellings | | | | | 50,000 | |
| Improvement of aids | | 736,000 | 613,000 | 795,000 | 268,000 | 481,850.00 |
| Lighthouse depots | | 50,000 | 21,000 | 288,000 | 30,000 | 1,128,050.00 |
| Total for special works | 250,000 | 999,000 | 1,279,300 | 1,163,000 | 354,400 | 7,989,500.00 |
| Total maintenance and special works | 5,414,030 | 6,238,030 | 6,617,980 | 7,597,862 | 7,044,830 | 16,374,168.40 |

### EXPENDITURES FROM APPROPRIATIONS, LIGHTHOUSE SERVICE, FISCAL YEARS 1915–1919.

[Actual expenditures, regardless of year of appropriation.]

| Expenditures. | 1915 | 1916 | 1917 | 1918 | 1919 |
|---|---|---|---|---|---|
| For maintenance | $5,111,121 | $5,002,706.25 | $5,220,473.07 | $6,246,088.83 | $6,694,537.90 |
| For special works | 500,516 | 748,833.50 | 651,298.99 | 499,633.24 | 880,958.40 |
| Total | 5,611,637 | 5,751,539.75 | 5,871,772.06 | 6,745,722.07 | 7,575,496.30 |

In addition to the appropriations listed above, funds have been received from the Navy Department, or are to be transferred as required, in payment of expenditures and obligations by the Lighthouse Service during the fiscal year 1919, on account of vessels and stations temporarily transferred to that department, and for which the appropriations of the Lighthouse Service were to that extent insufficient, as follows:

| | |
|---|---|
| To credit of general expenses, Lighthouse Service, 1919 | $625,000 |
| To credit of salaries, lighthouse vessels, 1919 | 200,000 |
| Total | 825,000 |

The amount transferred to the credit of salaries, lighthouse vessels, 1919, proved to be in excess of that required, and the unused balance will be returned to the Navy Department as soon as all obligations are ascertained.

Financial benefits not included in the above statement were received by the Lighthouse Service from the following sources:

During the fiscal year 1919 employees of the Lighthouse Service were paid a total of $375,252 from the appropriation increase of compensation, Department of Commerce, in addition to salaries paid from Lighthouse appropriations.

Medical treatment by the Public Health Service, without charge, was received by approximately 566 employees of the Lighthouse Service during the fiscal year for an aggregate of approximately 4,200 days.

Compensation for injuries under the employees' compensation law was received by some employees of the Lighthouse Service, and advantage was taken of the benefits of War Risk Insurance by some of the employees on vessels or at stations transferred to the Navy under the war emergency.

## LIGHTHOUSE DEPOTS.

Construction of the lighthouse depot for the sixteenth district, at Ketchikan, Alaska, for which an appropriation of $90,000 was made by act of July 1, 1918, was actively carried on during the year. On June 30, 1919, the wharf was about 95 per cent completed, and the entire work, including storehouse, shops, etc., about 35 per cent completed.

Important improvements are in progress at the General Lighthouse Depot, Tompkinsville, N. Y. The act of March 28, 1918, appropriated $60,000 for repairs to the wharves. This work includes the removal of the old, wooden wharf decks and relaying them with reinforced concrete, with the installation of additional steelwork, cast-iron pile columns, manholes, etc. In order to permit use of the wharves while improvements are in progress, the work is being done in three sections, one at a time. The first section, the south wharf, was completed in February, 1919. It is expected that the second section will be completed about September, 1919, after which the remaining section will be taken up. The act of June 20, 1918, authorized $65,000 for improving and extending the wharves at this depot, but no appropriation has been made. It is intended to extend the wharves eastward to the harbor line forming an outer basin, as the present inclosed basin is entirely too small to accommodate the vessels which now tie up there.

In August, 1918, the President approved and authorized an allotment of $175,000 from the fund for the national security and defense for certain necessary improvements at the general lighthouse depot, consisting of the removal of certain buildings and the construction of a new boiler and plate shop, a new iron shed and racks, and a new coal pocket. The allotment also covers the machinery and equipment needed for these structures. The work is well under way, and the entire project will be completed about December 30, 1919.

The act of July 19, 1919, appropriated $30,000 for extending and enlarging the machine shop at this depot, and plans are being prepared.

The act of June 12, 1917, appropriated $21,000 for improving the office and laboratory at this depot. This work has been completed, except the installation of a heating system and other work of minor importance.

The act of July 1, 1918, appropriated $85,000 for the construction of a depot for the second lighthouse district. A portion of the old marine-hospital property in Chelsea has been transferred as a site for this depot. The work is in progress, but the amount available is quite insufficient for the complete construction under existing conditions.

The act of June 20, 1918, authorized $275,000 for improvements at the lighthouse depot at Portsmouth, Va., or establishing a new depot, but no appropriation has been made for this work. This is the principal depot of one of the largest lighthouse districts and is the headquarters for five tenders and two light vessels during the greater part of the year. The facilities for berthing these vessels are entirely inadequate, and the efficient operation of the vessels is much hampered in consequence. The inadequacy of space for storing and handling buoys also causes much delay and loss. Increased facilities for this depot are urgently necessary.

A new depot for the seventh lighthouse district, at Key West, Fla., is urgently needed for the efficient and economical handling of the work of the district. The present depot is located on property belonging to the Treasury Department, with naval coal sheds and piers on either side, where coal dust is practically always in motion and finds its way into the storehouse. The space allotted the Lighthouse Service for buoys and appendages is entirely inadequate, and the dock is often necessarily used by naval vessels, causing delays and hindering the work of lighthouse vessels. The depot consists of a wooden storehouse, which is built on a wooden pier. There is no oil house at this depot, due to lack of space, and kerosene, gasoline, and other inflammable supplies have to be kept in the storehouse, constituting a constant menace of fire.

Suitable depot facilities at Honolulu for the nineteenth lighthouse district are also much needed, and an estimate has been submitted for this purpose. The act of August 28, 1916, authorized this work in the amount of $90,000, but no appropriation has been made.

The act of June 20, 1918, authorized $88,500 for constructing a depot for the eighth lighthouse district at New Orleans, La., but no appropriation has been made therefor. A lighthouse depot at New Orleans, La., is of importance for the convenient and economical administration of the district, and estimate for appropriation has been submitted.

The new lighthouse depot at Charleston, S. C., for which an appropriation was made by the act of October 22, 1913, has been completed so far as funds permitted and was occupied regularly for the first time on August 1, 1916. Further improvements at Charleston Depot are needed, for which an estimate is submitted.

The act of July 1, 1918, appropriated $53,000 for improvements at the Detroit Lighthouse Depot, Mich. Work on this project is in progress; it includes a concrete wharf to replace the present timber structure and the enlargement of the lamp shop and warehouse.

The amount appropriated will not be sufficient to complete these projects as planned, owing to the increased cost of materials and labor since the estimate was submitted. An additional estimate will be submitted to provide for completing the work as originally planned and for some further necessary improvements.

The present quarters at the Goat Island Lighthouse Depot, Cal., consist of two old frame dwellings, and are inadequate, unsanitary, and poorly arranged. An estimate is submitted for constructing two dwellings of modern design and proper location adjacent to the depot.

A new depot is greatly needed at Newport, R. I., or vicinity, and an estimate therefor has been submitted. The present depot for this locality is situated on the breakwater at Newport Harbor. This location is unsatisfactory and inconvenient, as the water at the dock is too shoal for the larger tenders, and there are no facilities for getting provisions, fresh water, ice, etc., causing much loss of time during working hours. The dock is in very bad condition, and the space for the Lighthouse Service is inadequate, due to extensions of operations by the Navy Department.

## LIGHTHOUSE TENDERS.

The tenders of the Service have been employed to good advantage during the year. The 55 vessels which have been in commission have steamed a total of about 470,000 nautical miles in their work of supplying light vessels and light stations, maintaining the buoyage system, transporting construction materials, and carrying the officers and employees of the Service to their stations or on inspection duty, in addition to work performed in cooperation with other Government departments.

The tenders of this service have been more actively engaged during the past year than ever before. The Executive order transferring all tenders but one to the War and Navy Departments during the period of the war entailed additional and arduous duties on the vessels under these departments which resulted in serious handicaps in the carrying on of urgent work of this Service, which in many cases required simultaneous attention.

The tenders were in constant service, and due to their construction and equipment were well adapted to the work required by the other departments, particularly the Navy, and were selected for the establishment and maintenance of the submarine nets located at the entrances to the main ship channels of various ports. After the armistice was signed and hostilities ceased, the vessels were employed in the removal of miles of network which taxed them to their utmost, the work requiring the best of care and skill, but was accomplished satisfactorily and with dispatch.

An appropriation of $20,000 was made by the act of July 1, 1916, for a light-draft tender and barge for use in establishing and maintaining aids along the intercoastal waterways of Texas and Louisiana. Proposals have been twice advertised for this equipment without satisfactory results. Plans and specifications have been prepared and bids are to be invited for a light-draft tender of special design for the shoal waters of the inland waterways. It is proposed to purchase or construct a working barge with pile driver and gear from the balance of the appropriation remaining.

With the increase in the number of aids to navigation and the deterioration of older vessels, it will be necessary to construct on an average of two new tenders each year. A full statement as to the need of vessels is given on pages 696 to 701. The act of June 12, 1917, appropriated $150,000 to replace the tender *Gardenia*, which has been surveyed and laid up as being of no further use to the Service. Bids received for this work being greatly in excess of the appropriation were rejected.

Estimates have been submitted for new lighthouse tenders to replace the present tenders *John Rodgers*, *Jessamine*, and *Holly*, or for general service, as may be found most desirable. The vessels mentioned are all old, unseaworthy, sidewheel steamers, which should be laid up as soon as arrangements can be made. The act of June 20, 1918, authorized building three tenders and a light vessel, but no appropriation has been made.

The tender *Pine*, a small tender constructed for use along the inlets of the New Jersey coast, was completed and placed in commission on December 9, 1918. A description of this vessel is given on page 736.

The tender *Elm*, a working power barge for use on the Hudson River, was completed and placed in commission July 18, 1919. A description of this vessel is given on page 736.

Several small vessels no longer required by the Navy Department were examined by representatives of the Bureau with the view of the transfer to the Lighthouse Service of such as were suitable for lighthouse purposes. The 75-foot converted yacht *Elmasada* and the 50-foot converted passenger boat *Niagara*, both constructed of wood, and which are gasoline propelled, were accordingly transferred to the Lighthouse Service May 31 and June 4, 1919, respectively, and renamed *Cosmos* and *Poinsettia*. These small tenders are intended for use on lighthouse work in shoal and inland waters.

The tender *Gardenia*, which was surveyed, condemned, and laid up on March 1, 1917, being of no further use for lighthouse purposes, was transferred to the Navy Department for such temporary service as it could be used for during the period of the war. It was transferred back to the Lighthouse Service on July 28, 1919, and bids for its sale advertised to be opened August 14, 1919. No bids were received. The sale was readvertised and bids opened September 19, 1919. The highest bid received was $1,065, which was accepted and the tender delivered to the purchaser.

The following tenders have either been extensively overhauled or such work has been started during the fiscal year 1919: *Arbutus*, *Hibiscus*, *Iris*, *Madrono*, *Maple*, *Mangrove*, *Magnolia*, *Marigold*, *Snowdrop*, and *Zizania*.

It is probable that during the current year extensive overhaul will be completed or undertaken on the following tenders: *Amaranth*, *Arbutus*, *Columbine*, *Dandelion*, *Hibiscus*, *Juniper*, *Manzanita*, *Madrono*, *Maple*, *Mangrove*, *Myrtle*, *Oleander*, *Orchid*, and *Sumac*.

The following was the number of tenders of the Lighthouse Service on June 30 of the years specified, omitting vessels not having regular crews and those less than 50 feet in length: 1910, 51; 1911, 46; 1912, 45; 1913, 44; 1914, 45; 1915, 46; 1916, 47; 1917, 51; 1918, 51; 1919, 55. On June 30, 1919, the following was the status of the tenders: In actual service, 52; undergoing repairs, 3.

## LIGHT VESSELS.

The Lighthouse Service maintains light vessels on 50 stations and has for this purpose 65 light vessels, of which 13 are relief vessels. Some of these vessels are old, 3 having been built over 50 years ago; 8 having been built over 60 years ago; 1 is 70 years old. Some of the older vessels are in a condition which does not warrant extensive repairs.

On the afternoon of August 6, 1918, Diamond Shoal Light Vessel *No. 71*, N. C., was fired upon and sunk by an enemy submarine while moored on her station off Cape Hatteras, N. C. The 12 men on board the light vessel, consisting of 2 officers, 2 radio operators, and 8 crew, quickly took to one of the boats before the vessel sank and landed safely about 1 mile north of Cape Hatteras Lighthouse, but lost all of their belongings, which were left on board the light vessel.

Relief Light Vessel *No. 51*, stationed on Cornfield Point Light Vessel station, Conn., was collided with and sunk by a barge in tow of a Standard Oil tug on April 24, 1919. The light ship went down in eight minutes after being struck. Good judgment and discipline by officers and crew on the light vessel were shown in the emergency. No injury was sustained by any of the crew. The lifeboat and log and fog-signal books were the only property of the light vessel saved. This vessel was of iron, built in 1892. The owner of the tow has been called upon to indemnify the Government.

Bush Bluff Light Vessel *No. 97* was surveyed, condemned, and recommended for sale by a board of survey on July 10, 1918, a careful examination of the vessel showing that it was of no further use to the Lighthouse Service, being beyond economical repair. The sale was widely advertised and bids invited to be opened March 20, 1919. No bids were received.

Thirty-Five Foot Channel Light Vessel *No. 45*, was surveyed, condemned, and recommended for sale by a board of survey on October 26, 1918. The vessel was partially destroyed by fire on March 3, 1918 and on close examination was found to be beyond economical repair. The vessel will be sold.

During the fiscal year 65 light vessels were in commission. New vessels under construction are light vessels *No. 99* and *No. 103*, for duty on the Great Lakes.

The act of June 20, 1918, authorized $760,000 for tenders and light vessels, which included a new light vessel for the Gulf coast, but no appropriation was made therefor. An estimate for this object is submitted.

The act of June 12, 1917, appropriated $130,000 for a light vessel for Cape Charles, Va., or for general service, plans and specifications were completed and bids invited for the construction of the vessel. The lowest bid received was greatly in excess of the appropriation. No expenditures were made from this appropriation to June 20, 1919.

The following light vessels have either been extensively overhauled or such work has been started during the last fiscal year: *No. 1*, *No. 13*, *No. 41*, *No. 49*, *No. 74*, *No. 81*, *No. 83*, *No. 88*.

With the deterioration of the older light vessels now in service, it will be necessary to construct on an average of two new light vessels each year. A full statement as to the need of vessels is made on pages 696 to 701.

It is probable that during the current fiscal year extensive overhaul will be completed or undertaken on the following light vessels: *No. 1*, *No. 5*, *No. 11*, *No. 34*, *No. 47*, *No. 56*, *No. 57*, *No. 66*, *No. 68*.

The following was the total number of light vessels and stations on June 30 of the years named:

| Year. | Light vessels. | Light-vessel stations. | Year. | Light vessels. | Light-vessel stations. |
|---|---|---|---|---|---|
| 1910 | 68 | 54 | 1915 | 66 | 53 |
| 1911 | 63 | 51 | 1916 | 66 | 53 |
| 1912 | 65 | 51 | 1917 | 68 | 53 |
| 1913 | 67 | 53 | 1918 | 67 | 52 |
| 1914 | 66 | 52 | 1919 | 65 | 50 |

Of the present light vessels, 36 have self-propelling machinery and 27 are provided with only sail power. Two have no means of propulsion.

On June 30, 1919, the following was the status of the light vessels: Regular vessels on station, 45; relief vessels on station, 5; relief vessels at depots, 7; regular vessels under repair, 5; relief vessels under repair, 1; regular vessels laid up, 2; relief vessels laid up, 0.

## REPORT OF OPEN-MARKET PURCHASES.

In compliance with the act of June 17, 1910, there is submitted separately as a part of this report a list of purchases of materials and supplies for the Lighthouse Service made without obtaining bids under public advertisement, with the reasons for so purchasing.

## LEGISLATION ENACTED AFFECTING THE LIGHTHOUSE SERVICE.

The deficiency appropriation act of November 4, 1918, appropriated $300,000 for repairing ice and storm damage on the Atlantic Coast; $60,000 for purchase of additional gas buoys for improvement of aids to navigation, fifth lighthouse district; and $80,000 for improving, repairing, establishing, and moving aids to navigation, St. Marys River, Mich., and vicinity.

The sundry civil act approved July 19, 1919, made the following appropriations: Execution Rocks Light Station, N. Y., restoring and improving the light station, $10,000; Point Jiguero Light Station, P. R., rebuilding the station, $24,000; Manitowoc Breakwater Light Station, Wis., improving the light and fog-signal station, $9,000; Chicago Harbor Light Station, Ill., completing the removal and rebuilding of the light station and establishing lights on the new breakwater in Chicago Harbor, $6,400; light-keepers' dwellings, for light keepers' dwellings and appurtenant structures, including sites therefor within the limit of cost fixed by the act approved February 26, 1907, $50,000; Tompkinsville, Staten Island (N. Y.) Lighthouse Depot, extending and enlarging the machine shop, $30,000; third lighthouse district, riprap to reinforce foundations of light stations and constructing or improving boat landings, $150,000; Alaska, establishing new aids to navigation and improvements of existing aids, $75,000.

The appropriations for the maintenance of the Lighthouse Service for the fiscal year 1920 are shown in tables on page 753.

The act of November 4, 1918, amended the retirement law affecting the field service to the extent that the provisions of this law do not apply to persons in the field service whose duties do not require substantially all their time.

The legislative act of March 1, 1919, provided for increased compensation during the fiscal year 1920 at the rate of $240 per annum to all civilian employees of the Government, with certain exceptions, whose compensation does not exceed $2,500 per annum, in lieu of the $120 per annum increase in force during the preceding fiscal year, but as a provision of the law excluded employees whose duties require only a portion of their time, a considerable number of lighthouse employees were affected and suffered what amounted to a virtual reduction in pay at a very inopportune time.

The following works were authorized by the act of June 20, 1918, at the limits of cost specified, but except St. Marys River, have not yet been appropriated for. Constructing or purchasing and equipping lighthouse tenders and light vessels to replace vessels worn out in service in the third, fifth, and eighth lighthouse districts, or for use in the Lighthouse Service generally, $760,000; enlarging and improving the lighthouse depot at Portsmouth, Va., in the fifth lighthouse district, or establishing a new depot, $275,000; improving, repairing, establishing, and moving aids to navigation in St. Marys River, Mich., and vicinity, $80,000; extending and enlarging the machine shop at the general lighthouse depot; Tompkinsville, Staten Island, N. Y., $30,000; establishing and improving aids to navigation in the Virgin Islands of the United States and adjacent waters, West Indies, $50,000; improving and extending the wharves at the General Lighthouse Depot, Tompkinsville, Staten Island, N. Y., $65,000; improving the aids to navigation and installing new aids in the Potomac River, Md. and Va., $95,000; constructing and equipping a lighthouse depot for the eighth lighthouse district at New Orleans, La., or vicinity, $88,500. Estimates for these items have been submitted, some at an increased cost due to increased prices since originally submitted.

## SPECIAL LEGISLATION NEEDED.

The act of August 29, 1916, authorizing the President to transfer to the Navy or War Department portions of the Lighthouse Service when there is a national emergency should be amended so as to definitely define the status of the personnel transferred. All persons so transferred who serve on vessels or at stations where they are exposed to the risks of war should have a suitable military status and be entitled to all relief provided by legislation for those in the military services. Particularly the officers of vessels of the Lighthouse Service, frequently called upon to cooperate with vessels of the Navy, should have suitable military standing. Although the personnel transferred were, under rulings of the Treasury Department, given the benefits of the War Risk Insurance, there was considerable conflict in decisions as to their standing under the act of August 29, 1916. All of the personnel were in an indefinite and anomalous position in their relations with the military and naval personnel. Specific recommendation is deferred until conditions become more settled after the war.

In any future transfer of vessels there should, if practicable, be more definite understanding as to the extent to which tenders are to be diverted from their lighthouse duty. The upkeep of the system of aids to navigation requires every effort of the present equipment of tenders, and their efficient maintenance is even more important in time of war than in normal times.

Legislation is recommended to cover adjustment of claims by lighthouse employees for loss of or damage to personal property, such as clothing, furniture, etc., caused by storms, tidal waves, collisions, or fire at light stations, depots, and on vessels. Such provision should be made in justice to these employees engaged on hazardous duty. By act of June 17, 1910, it was provided that claims against the Government for damages not exceeding $500 arising out of collisions for which lighthouse vessels are responsible be determined and settled by the Commissioner of Lighthouses. This provision has worked satisfactorily, enabling the Government to adjust claims promptly and relieving Congress of the annoyance of many petty claims; and similar legislation covering losses of personal property by lighthouse employees under the circumstances referred to would be advantageous to the Government and result in more equal justice to employees. Light stations are for the most part situated at remote, isolated points where in case of severe storm, tidal wave, fire, or other calamity it is difficult or impossible to obtain assistance for the saving of property. The light keepers in such emergencies, faithful to their duties and to the call of humanity, invariably have devoted themselves to the maintenance of the lights, the saving of public property, or to the protection or rescue of human life. As a result their own property has sometimes been destroyed or seriously damaged. This may represent the accumulations of a lifetime and a serious loss. The furnishings and equipment of light stations provided by the Government are designed only for actual necessities for the performance of a keeper's duties, and keepers must necessarily have personal property at the station. Similar conditions exist with reference to men on lighthouse vessels, though the personal property in such cases is generally confined to wearing apparel. The number of such cases has not been great, and the quantity of general relief by legislation would not involve the Government in any great expenditure. Congress has in the past occasionally passed special legislation reimbursing employees of the Lighthouse Service for their personal property lost or destroyed, but the process of securing such legislation is slow and in the majority of cases has failed, and the present lack of system consequently results in very unequal justice. The conditions and limitations proposed are practically the same as those which Congress has already provided by law for reimbursement for losses sustained by men in the military service (Mar. 3, 1885; 23 Stat., 350) and in the naval service (Mar. 2, 1895; 28 Stat., 962).

Legislation is recommended authorizing the establishment and maintenance of post-lantern lights and other aids to navigation of the Yukon River and its tributaries, Alaska. The waters of the Yukon delta are already being marked, but Congressional authority is required for the Lighthouse Service to extend its jurisdiction to the nontidal waters of these rivers. Navigation of the Yukon River is increasing and as it is navigable for a long distance many lights and day marks are required to safeguard shipping.

Legislation is also recommended providing for medical relief for lighthouse keepers, without charge, at other than hospitals and stations of the Public Health Service. The act of August 28, 1916 (39 Stat., 538), provided for medical relief without charge for light keepers and assistant light keepers of the Lighthouse Service at hospitals and stations of the Public Health Service under the rules and regulations governing the care of seamen of the merchant marine. The hospitals and stations of the Public Health Service are for the most part located at the principal ports, and while convenient for the use of seamen are inaccessible for a large number of lighthouse keepers who are stationed at remote and isolated points. Many keepers are, therefore, unable to avail themselves of the benefits of the legislation heretofore enacted. The Secretary of the Treasury in a letter of May 28, 1919, to the Secretary of Commerce concurred in the recommendation for such legislation.

The act of June 20, 1918, providing for voluntary retirement at the age of 65 after 30 years' service, and compulsory retirement at the age of 70, for certain classes of employees of the Lighthouse Service has proved beneficial both to the men eligible to retirement and to the Service in replacing such men with younger and more capable employees. Still greater efficiency, however, will result, and hardship to deserving employees will be avoided if the same benefits are extended to persons who become disabled from efficiently performing their duties by reason of disability incident to their work, such disability being distinct from that caused by injury received in the line of duty, for which compensation is now provided by law, and legislation to this end is recommended.

The officers of the Lighthouse Service are strongly of the opinion that the interests of the Government would be further benefited, in the attainment of a higher degree of efficiency, as well as in affording justice to deserving employees, by the enactment of legislation providing for a system of general retirement for the civil employees of the Government, including office and shop employees of the Lighthouse Service, the need of such legislation being particularly apparent in the work of this Service.

The statistics as to the various classes of aids to navigation and fuller details on many of the subjects mentioned in this report will be found in the pages following.

Respectfully,

GEORGE R. PUTNAM,
*Commissioner of Lighthouses.*

To Hon. WILLIAM C. REDFIELD,
*Secretary of Commerce.*

# STATISTICS AND ESTIMATES.

## LIST OF OFFICERS OF THE BUREAU OF LIGHTHOUSES AND THE LIGHTHOUSE DISTRICTS.

### OFFICERS OF THE BUREAU OF LIGHTHOUSES ON JUNE 30, 1919.

| | |
|---|---|
| George R. Putnam | Commissioner of Lighthouses. |
| John S. Conway | Deputy Commissioner. |
| H. B. Bowerman | Chief Constructing Engineer. |
| Edward C. Gillette | Superintendent of Naval Construction. |

Principal Assistant Engineer, Rudolph Zirpel.
Superintendent on general duty, E. M. Trott.
Chief Clerk, Thaddeus S. Clark.
Examiner, Thomas Flood.

### SUPERINTENDENTS OF LIGHTHOUSE DISTRICTS JULY 1, 1918, TO JUNE 30, 1919.

| District. | Name. | From— | To— |
|---|---|---|---|
| 1st | C. E. Sherman | July 17, 1911 | |
| 2d | R. H. Goddard | June 27, 1912 | Mar. 4, 1919 |
| | G. E. Eaton | Mar. 7, 1919 | |
| 3d | J. T. Yates | June 20, 1912 | |
| 4th | T. J. Rout | Mar. 1, 1912 | |
| 5th | H. D. King | Jan. 28, 1915 | |
| 6th | H. L. Beck | Jan. 28, 1915 | |
| 7th | W. W. Demeritt | Aug. 22, 1913 | |
| 8th | B. B. Dorry | June 6, 1912 | |
| 9th | F. C. Hingsburg | Jan. 28, 1918 | |
| 10th | Roscoe House | June 4, 1912 | |
| 11th | E. L. Woodruff | Aug. 19, 1912 | |
| 12th | C. H. Hubbard | May 1, 1918 | |
| 13th | Maj. Gen. A. Mackenzie, U. S. Army, retired | May 29, 1917 | June 8, 1919 |
| | Col. H. Burgess, Corps of Engineers, U. S. Army | June 9, 1919 | |
| 14th | Col. Lansing H. Beach, Corps of Engineers, U. S. Army | Aug. 10, 1915 | |
| 15th | Brig. Gen. Wm. H. Bixby, U. S. Army, retired | Sept. 17, 1917 | Jan. 31, 1919 |
| | Col. C. McD. Townsend, Corps of Engineers, U. S. Army | Feb. 1, 1919 | |
| 16th | W. C. Dibrell | Aug. 22, 1913 | |
| 17th | Robert Warrack | Feb. 1, 1915 | |
| 18th | H. W. Rhodes | July 6, 1912 | |
| 19th | A. E. Arledge | Sept. 3, 1912 | |

## JURISDICTION OF LIGHTHOUSE SERVICE.

The United States Lighthouse Service is charged with the establishment and maintenance of aids to navigation and with all equipment and work incident thereto on the sea and lake coasts of the United States, on the rivers of the United States so far as specifically authorized by law, and on the coasts of all other territory under the jurisdiction of the United States, with the exception of the Philippine Islands and Panama. The total length of coast line and rivers under the United States Lighthouse Service, measured by steps of 3 miles, is approximately 47,300 miles.

## LIMITS OF LIGHTHOUSE DISTRICTS AND ADDRESSES OF SUPERINTENDENTS OF LIGHTHOUSES.

| District. | Limits of district. | Address of superintendents. |
|---|---|---|
| 1st | Waters of Maine and New Hampshire | Y. M. C. A. Building, Portland, Me. |
| 2d | Waters of Massachusetts | Customhouse, Boston, Mass. |
| 3d | Waters of Rhode Island, Connecticut, New York, and New Jersey northward of Cape May. | Tompkinsville, N. Y. |
| 4th | Waters of Delaware seacoast and Delaware Bay and River. | Post Office Building, Philadelphia, Pa. |
| 5th | Waters of Maryland, Virginia, and North Carolina to and including New River Inlet, N. C. | New Customhouse, Baltimore, Md. |
| 6th | From New River Inlet, N. C., to Hillsboro Inlet, Fla. | Old Post Office Building, Charleston, S. C. |
| 7th | Waters of Florida from Hillsboro Inlet to Cedar Keys. | Key West, Fla. |
| 8th | Waters of Gulf Coast from Cedar Keys, Fla., to mouth of Rio Grande, Tex., and Mississippi River below New Orleans. | Customhouse, New Orleans, La. |
| 9th | Waters of Porto Rico and adjacent United States islands. | San Juan, P. R. |
| 10th | United States waters of St. Lawrence River and Lakes Ontario and Erie. | Federal Building, Buffalo, N. Y. |
| 11th | United States waters of Lakes St. Clair, Huron, and Superior, and Detroit River. | Post Office Building, Detroit, Mich. |
| 12th | Waters of Lake Michigan and Green Bay | Federal Building, Milwaukee, Wis. |
| 13th | Mississippi River above the mouth of the Missouri River, Minnesota, Illinois, Osage, Gasconade, and Missouri Rivers. | Federal Building, Rock Island, Ill. |
| 14th | Ohio, Tennessee, Kanawha, and Monongahela Rivers. | Customhouse, Cincinnati, Ohio. |
| 15th | Mississippi River below the Missouri River to New Orleans, La., and Red River. | Customhouse, St. Louis, Mo. |
| 16th | Waters of Alaska | Ketchikan, Alaska. |
| 17th | Waters of Washington and Oregon | Customhouse, Portland, Oreg. |
| 18th | Waters of California | Customhouse, San Francisco, Calif. |
| 19th | Waters of Hawaiian, Midway, Guam, and American Samoan Islands. | McCandless Building, Honolulu, Hawaii. |

## LIGHTHOUSE DEPOTS MAINTAINED ON JUNE 30, 1919.

[The principal depot of the district is indicated by the larger type.]

| District. | Location. | District. | Location. |
|---|---|---|---|
| 1st | Bear Island, Me. | 8th | Fort San Jacinto, Galveston, Tex. |
|  | LITTLE DIAMOND ISLAND, ME. |  | Mobile, Ala. |
| 2d | LOVELLS ISLAND, BOSTON, MASS. |  | PORT EADS, LA. |
|  | Woods Hole, Mass. |  |  |
| 3d | Atlantic City, N. J. |  |  |
|  | Goat Island, R. I. | 9th | SAN JUAN, P. R. |
|  | Juniper Island, Vt. | 10th | BUFFALO, N. Y. |
|  | New London, Conn. |  | Erie, Pa. |
|  | TOMPKINSVILLE, STATEN ISLAND, N. Y. |  | Maumee Bay, Ohio. |
|  | Tucker Beach, N. J. |  | Rock Island, N. Y. |
| 4th | EDGEMOOR, DEL. |  | Sandusky Bay (Cedar Point), Ohio. |
|  | Lewes, Del. | 11th | DETROIT, MICH. |
| 5th | Annapolis, Md. |  | Minnesota Point, Minn. |
|  | Lazaretto Point, Md. |  | St. Marys River, Mich. |
|  | Point Lookout, Md. | 12th | Charlevoix, Mich. |
|  | PORTSMOUTH, VA. |  | MILWAUKEE, WIS. |
|  | Washington Wharf, D. C. | 16th | KETCHIKAN, ALASKA. |
|  | Washington, N. C. | 17th | Ediz Hook, Wash. |
| 6th | CHARLESTON, S. C. |  | TONGUE POINT, OREG. |
| 7th | Egmont Key, Fla. | 18th | GOAT ISLAND, CALIF. |
|  | KEY WEST, FLA. | 19th | HONOLULU, HAWAII. |

### EXPLANATION OF TABLE ON PAGE 723.

The table of aids to navigation includes all those maintained by the Lighthouse Service, a total of 16,075. On page 731 are given facts regarding the private aids to navigation, 786 in number, maintained under authority. In the statistics relief light vessels are not counted and duplicate or auxiliary lights and fog signals are not counted, but double lights are counted separately when maintained on distinct structures or for distinct purposes. Buoys for the purpose of marking the positions of light vessels or larger buoys are not counted. Fog signals at light stations or on vessels are counted as separate aids, but not those attached to buoys, except in the case of submarine bells, which are counted as separate signals, whether on vessels or on buoys. Otherwise each buoy is counted only once, and if it is included in a higher class it is not in the lower class. Light-vessel lights are not counted separately.

## AIDS TO NAVIGATION MAINTAINED BY THE UNITED STATES LIGHTHOUSE SERVICE, JUNE 30, 1919.

[See note on p. 722.]

| Class. | 1st dist. | 2d dist. | 3d dist. | 4th dist. | 5th dist. | 6th dist. | 7th dist. | 8th dist. | 9th dist. | 10th dist. | 11th dist. | 12th dist. | 13th dist. | 14th dist. | 15th dist. | 16th dist. | 17th dist. | 18th dist. | 19th dist. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LIGHTED AIDS. | | | | | | | | | | | | | | | | | | | | |
| Hyper-radiant lights | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 1 | 1 |
| First-order lights | 2 | 5 | 5 | 2 | 8 | 8 | 6 | 3 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 9 | 9 | ...... | 57 |
| Second-order lights | 7 | 3 | 2 | ...... | ...... | 2 | 1 | 2 | 1 | ...... | 3 | 2 | ...... | ...... | ...... | ...... | ...... | 1 | 2 | 26 |
| Third-order lights | 6 | 1 | 3 | 2 | ...... | 3 | 4 | 8 | 6 | 4 | 10 | 9 | ...... | ...... | ...... | 4 | 2 | 4 | 1 | 67 |
| Three-and-one-half-order lights | ...... | 2 | 1 | 3 | 1 | 1 | ...... | 3 | 1 | 3 | 6 | 2 | ...... | ...... | ...... | ...... | ...... | ...... | 1 | 24 |
| Fourth-order lights | 35 | 25 | 58 | 9 | 49 | 2 | 4 | 12 | 4 | 22 | 47 | 37 | ...... | ...... | ...... | 5 | 19 | 20 | 9 | 357 |
| Fifth-order lights | 18 | 15 | 18 | 4 | 21 | 3 | 1 | 13 | 3 | 10 | 14 | 12 | ...... | ...... | ...... | ...... | ...... | 2 | ...... | 134 |
| Sixth-order lights | 1 | 5 | 22 | 2 | 8 | ...... | ...... | ...... | 5 | 8 | 4 | 16 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 71 |
| Range-lens lights | ...... | ...... | 9 | 14 | 5 | 9 | ...... | ...... | ...... | 6 | 3 | ...... | ...... | ...... | ...... | ...... | 2 | ...... | ...... | 48 |
| Reflector lights | 2 | 7 | 1 | 12 | 17 | 37 | 13 | 8 | 2 | 6 | 27 | 4 | ...... | ...... | ...... | ...... | 2 | ...... | ...... | 138 |
| Lens-lantern lights | 12 | 27 | 59 | 21 | 46 | 64 | 38 | 157 | 21 | 39 | 91 | 48 | ...... | ...... | ...... | 101 | 29 | 38 | 38 | 829 |
| Minor lights | 3 | 18 | 171 | 27 | 298 | 178 | 76 | 109 | 2 | 1 | 84 | 7 | 457 | 569 | 766 | 64 | 286 | 14 | 2 | 3,132 |
| Electric lights without lens | 1 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 2 | ...... | ...... | ...... | ...... | ...... | ...... | 1 | 8 | 2 | 2 | 16 |
| Light-vessel stations | 1 | 11 | 10 | ...... | 6 | 4 | ...... | 2 | ...... | ...... | 5 | 6 | ...... | ...... | ...... | ...... | 3 | 2 | ...... | 50 |
| Gas-lighted buoys | 4 | 39 | 51 | 11 | 64 | 8 | 6 | 23 | 5 | 32 | 78 | 16 | ...... | ...... | ...... | 5 | 11 | 8 | 6 | 367 |
| Gas and whistling buoys | 7 | 6 | 11 | ...... | 11 | 8 | 5 | 9 | 1 | ...... | ...... | 1 | ...... | ...... | ...... | 1 | 6 | 8 | ...... | 74 |
| Gas and aerial bell buoys | ...... | 9 | 20 | 7 | 18 | 8 | 7 | 2 | ...... | 2 | 11 | 14 | ...... | ...... | ...... | 2 | 5 | 6 | 1 | 112 |
| Float lights | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 1 | 22 | 5 | 5 | 83 | 40 | ...... | 5 | 1 | ...... | ...... | 162 |
| **Total** | 99 | 173 | 441 | 114 | 552 | 335 | 161 | 351 | 54 | 155 | 388 | 179 | 540 | 609 | 766 | 188 | 383 | 114 | 63 | 5,665 |
| **Lights on fixed aids** | 87 | 108 | 349 | 96 | 453 | 307 | 143 | 315 | 47 | 99 | 289 | 137 | 457 | 569 | 766 | 175 | 357 | 90 | 56 | 4,900 |
| **Lights on floating aids** | 12 | 65 | 92 | 18 | 99 | 28 | 18 | 36 | 7 | 56 | 99 | 42 | 83 | 40 | ...... | 13 | 26 | 24 | 7 | 765 |
| **Total lighted aids** | 99 | 173 | 441 | 114 | 552 | 335 | 161 | 351 | 54 | 155 | 388 | 179 | 540 | 609 | 766 | 188 | 383 | 114 | 63 | 5,665 |
| UNLIGHTED AIDS. | | | | | | | | | | | | | | | | | | | | |
| Fog signals, engine power | 19 | 21 | 37 | 5 | 14 | 4 | ...... | 3 | ...... | 11 | 39 | 47 | ...... | ...... | ...... | 10 | 26 | 30 | ...... | 266 |
| Fog signals, clock power | 37 | 13 | 59 | 6 | 63 | 3 | 1 | 14 | ...... | 5 | 5 | 9 | ...... | ...... | ...... | 1 | 4 | 6 | ...... | 226 |
| Fog signals, hand power | 12 | 1 | 2 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 1 | 1 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 17 |
| Fog signols, electric | ...... | 5 | 4 | 1 | 4 | ...... | ...... | ...... | ...... | ...... | 6 | ...... | ...... | ...... | ...... | ...... | 1 | 4 | ...... | 25 |
| Submarine signals | 2 | 8 | 9 | ...... | 7 | 5 | ...... | 2 | ...... | ...... | 5 | 4 | ...... | ...... | ...... | 1 | 4 | 2 | ...... | 49 |
| Buoys, whistling (unlighted) | 19 | 10 | 8 | ...... | 2 | 6 | 3 | 5 | 1 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 7 | 18 | ...... | 79 |
| Buoys, bell (unlighted) | 53 | 37 | 57 | 5 | 28 | 7 | 8 | 15 | 4 | 1 | 1 | 3 | ...... | ...... | ...... | 3 | 8 | 15 | ...... | 245 |
| Buoys, iron | 149 | 64 | 155 | 108 | 263 | 288 | 216 | 169 | 133 | 10 | 26 | 29 | ...... | ...... | ...... | 164 | 130 | 56 | 60 | 2,020 |
| Buoys, spar (wood) | 704 | 620 | 901 | 93 | 982 | 6 | ...... | 178 | ...... | 158 | 489 | 139 | 553 | ...... | ...... | 44 | 131 | 30 | 7 | 5,035 |
| Daymarks, beacons, etc | 177 | 75 | 36 | 1 | 374 | 545 | 344 | 247 | 6 | ...... | 4 | 8 | 357 | 60 | ...... | 64 | 78 | 31 | 41 | 2,448 |
| **Total unlighted aids** | 1,172 | 854 | 1,268 | 219 | 1,737 | 864 | 572 | 633 | 144 | 185 | 576 | 240 | 910 | 60 | ...... | 287 | 389 | 192 | 108 | 10,410 |
| **Grand total** | 1,271 | 1,027 | 1,709 | 333 | 2,289 | 1,199 | 733 | 984 | 198 | 340 | 964 | 419 | 1,450 | 669 | 766 | 475 | 772 | 306 | 171 | 16,075 |

## DETAILS AS TO CHARACTERISTICS OF LIGHTS (NOT INCLUDING LIGHT VESSELS).[a]

| | 1st dist. | 2d dist. | 3d dist. | 4th dist. | 5th dist. | 6th dist. | 7th dist. | 8th dist. | 9th dist. | 10th dist. | 11th dist. | 12th dist. | 16th dist. | 17th dist. | 18th dist. | 19th dist. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fixed white: | | | | | | | | | | | | | | | | | |
| Sixth order and above.. | 31 | 30 | 52 | 16 | 60 | 25 | 4 | 28 | 7 | 22 | 29 | 23 | 1 | 3 | 2 | 4 | 337 |
| Below the sixth order... | 1 | 10 | 83 | 9 | 229 | 139 | 55 | 138 | 3 | 5 | 63 | 6 | 48 | 204 | 18 | 11 | 1,022 |
| Lighted buoys.......... | .... | .... | 5 | .... | .... | .... | .... | 1 | .... | 10 | 2 | 5 | 1 | .... | .... | .... | 24 |
| Fixed red: | | | | | | | | | | | | | | | | | |
| Sixth order and above.. | 14 | 10 | 22 | 2 | 20 | 20 | 9 | 8 | 3 | 15 | 34 | 27 | .... | 3 | .... | 3 | 90 |
| Below the sixth order... | 5 | 13 | 119 | 9 | 92 | 78 | 37 | 112 | 10 | 15 | 64 | 16 | 5 | 93 | 23 | 9 | 700 |
| Lighted buoys.......... | .... | 2 | 7 | .... | .... | .... | .... | .... | 1 | 12 | 3 | .... | 4 | 1 | .... | .... | 30 |
| Fixed green: | | | | | | | | | | | | | | | | | |
| Below the sixth order... | .... | .... | .... | .... | .... | .... | .... | .... | 1 | .... | .... | .... | .... | .... | .... | .... | 1 |
| Flashing or occulting: | | | | | | | | | | | | | | | | | |
| Sixth order and above.. | 15 | 17 | 40 | 30 | 26 | 17 | 15 | 10 | 10 | 20 | 41 | 18 | 8 | 25 | 34 | 7 | 333 |
| Below the sixth order... | 9 | 22 | 28 | 30 | 23 | 25 | 22 | 16 | 13 | 20 | 48 | 33 | 113 | 26 | 13 | 22 | 463 |
| Lighted buoys.......... | 11 | 52 | 70 | 18 | 93 | 24 | 18 | 33 | 6 | 34 | 89 | 31 | 8 | 22 | 22 | 7 | 538 |
| Fixed and flashing, sixth order and above.......... | 12 | 6 | 5 | .... | 3 | 3 | 1 | 3 | 2 | 2 | 10 | 14 | .... | 3 | .... | .... | 64 |
| Candlepower: | | | | | | | | | | | | | | | | | |
| 50,000 to 190,000.......... | 5 | 4 | 4 | 7 | 4 | 7 | 5 | 5 | 3 | 4 | 7 | 1 | 1 | 2 | 9 | 1 | 69 |
| 200,000 to 490,000......... | .... | 1 | 2 | 1 | 1 | 1 | 1 | 1 | .... | .... | 3 | 1 | 1 | 1 | 2 | 1 | 17 |
| 500,000 and over......... | .... | 1 | 1 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 1 | 3 |
| Twin light stations.......... | 2 | 3 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 5 |
| Stations with resident keepers...................... | 70 | 47 | 112 | 30 | 88 | 22 | 12 | 50 | 21 | 35 | 74 | 66 | 10 | 35 | 38 | 14 | 724 |

## DETAILS AS TO ILLUMINANTS OF LIGHTS (NOT INCLUDING LIGHT VESSELS).[a]

| | 1st dist. | 2d dist. | 3d dist. | 4th dist. | 5th dist. | 6th dist. | 7th dist. | 8th dist. | 9th dist. | 10th dist. | 11th dist. | 12th dist. | 16th dist. | 17th dist. | 18th dist. | 19th dist. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Incandescent oil vapor...... | 28 | 25 | 39 | 18 | 19 | 15 | 11 | 13 | 11 | 9 | 39 | 29 | 3 | 26 | 27 | 6 | 318 |
| Oil (wick lamps): | | | | | | | | | | | | | | | | | |
| Sixth order and above.. | 43 | 31 | 78 | 6 | 72 | 40 | 12 | 29 | 10 | 36 | 42 | 41 | 3 | 2 | 2 | 7 | 454 |
| Below the sixth order... | 6 | 15 | 188 | 16 | 303 | 217 | 92 | 223 | 10 | 19 | 101 | 19 | 52 | 81 | 36 | 14 | 1,592 |
| Lighted buoys.......... | .... | .... | .... | .... | .... | .... | .... | .... | 1 | 22 | 5 | 5 | 5 | 1 | .... | .... | 39 |
| Acetylene: | | | | | | | | | | | | | | | | | |
| Sixth order and above.. | .... | 2 | 1 | 15 | 9 | 10 | 4 | 7 | 1 | 8 | 13 | 4 | 3 | 2 | 1 | 1 | 81 |
| Below the sixth order... | 9 | 22 | 38 | 27 | 23 | 25 | 22 | 43 | 7 | 18 | 27 | 33 | 113 | 17 | 11 | 22 | 457 |
| Lighted buoys.......... | 6 | 28 | 33 | 6 | 50 | 24 | 15 | 9 | .... | .... | 23 | 7 | 8 | 17 | 10 | 7 | 243 |
| Oil gas: | | | | | | | | | | | | | | | | | |
| Lights with mantles.... | .... | .... | .... | .... | 1 | .... | .... | .... | 1 | .... | 50 | .... | .... | .... | .... | .... | 52 |
| Lights without mantles. | .... | .... | 1 | .... | 15 | .... | .... | .... | 1 | .... | 1 | .... | .... | .... | .... | .... | 18 |
| Lighted buoys with mantles............... | 1 | .... | 13 | 2 | 32 | .... | .... | 2 | 2 | 34 | 66 | 22 | .... | 5 | 7 | .... | 186 |
| Lighted buoys without mantles............... | 4 | 26 | 36 | 10 | 11 | .... | 3 | 23 | 4 | .... | .... | 2 | .... | .... | 5 | .... | 124 |
| Electric arc: | | | | | | | | | | | | | | | | | |
| Sixth order and above.. | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 1 | .... | 1 |
| Below the sixth order... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 2 | .... | .... | 2 |
| Electric incandescent: | | | | | | | | | | | | | | | | | |
| Sixth order and above.. | 1 | 3 | 1 | 9 | 8 | .... | 2 | .... | .... | 6 | 12 | 7 | .... | 4 | 5 | .... | 58 |
| Below the sixth order... | .... | 8 | 3 | 5 | 3 | .... | .... | .... | 8 | 3 | 4 | 3 | 1 | 23 | 7 | 6 | 74 |
| Gas (coal), sixth order and above.................... | .... | 2 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 1 | .... | .... | .... | .... | 3 |

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[a] Does not include the thirteenth, fourteenth, and fifteenth lighthouse (river) districts, in which there are 1,792 lights on fixed aids and 123 lights on floating aids, all of which use kerosene and are fixed, except in 4, which use acetylene and are flashing, and 1 which uses electricity.

## DETAILS AS TO LIGHTS ON LIGHT VESSELS.

| | 1st dist. | 2d dist. | 3d dist. | 5th dist. | 6th dist. | 8th dist. | 11th dist. | 12th dist. | 17th dist. | 18th dist. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics as to lights: | | | | | | | | | | | |
| 1 fixed white light | .... | 3 | 1 | .... | 1 | .... | 4 | 4 | .... | .... | 13 |
| 2 fixed white lights | .... | 1 | 3 | 1 | .... | 1 | .... | .... | 2 | 1 | 9 |
| 1 fixed red light | .... | .... | .... | .... | .... | .... | .... | 1 | .... | .... | 1 |
| 2 fixed red lights | .... | 2 | .... | .... | .... | .... | .... | .... | .... | .... | 2 |
| 1 fixed white and 1 fixed red light | .... | 1 | .... | .... | 1 | .... | .... | .... | 1 | .... | 3 |
| 1 white flashing, or occulting, and 1 fixed red light | .... | .... | 2 | .... | .... | .... | .... | .... | .... | .... | 2 |
| 1 white light, flashing or occulting | 1 | 4 | 4 | 4 | 2 | 1 | 1 | 1 | .... | 1 | 19 |
| 2 white lights, flashing or occulting | .... | .... | .... | 1 | .... | .... | .... | .... | .... | .... | 1 |
| **Illuminants:** | | | | | | | | | | | |
| Incandescent oil vapor | .... | 1 | .... | .... | 1 | 1 | .... | .... | .... | .... | 3 |
| Acetylene | 1 | 3 | 5 | 4 | 2 | .... | .... | .... | .... | .... | 15 |
| Oil (wick) | .... | 6 | 3 | 1 | 1 | 1 | 4 | 5 | 3 | 1 | 25 |
| Oil (wick) and acetylene | .... | .... | 1 | .... | .... | .... | .... | .... | .... | .... | 1 |
| Electric arc | .... | .... | 1 | .... | .... | .... | .... | .... | .... | .... | 1 |
| Electric incandescent | .... | 1 | .... | 1 | .... | .... | 1 | 1 | .... | 1 | 5 |
| **Illuminating apparatus:** | | | | | | | | | | | |
| Fourth order | .... | 1 | .... | 1 | 1 | 1 | .... | 1 | .... | .... | 5 |
| Reflector | .... | 2 | 3 | 1 | 1 | .... | 2 | .... | 1 | .... | 10 |
| Reflector and lens lantern | .... | .... | 2 | .... | .... | .... | .... | .... | .... | .... | 2 |
| Lens lantern | 1 | 8 | 5 | 4 | 2 | 1 | 3 | 5 | 2 | 2 | 33 |

## DETAILS AS TO FOG SIGNALS.

| Kind and how operated. | 1st dist. | 2d dist. | 3d dist. | 4th dist. | 5th dist. | 6th dist. | 7th dist. | 8th dist. | 10th dist. | 11th dist. | 12th dist. | 16th dist. | 17th dist. | 18th dist. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Steam:** | | | | | | | | | | | | | | | |
| Whistle | 8 | 5 | 6 | .... | 4 | 2 | .... | 1 | 3 | 30 | 31 | .... | 3 | 5 | 98 |
| Siren | .... | .... | 1 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 1 | 1 | 3 |
| **Air:** | | | | | | | | | | | | | | | |
| Whistle | 1 | 4 | .... | .... | .... | .... | .... | .... | .... | .... | 5 | .... | .... | .... | 10 |
| Siren | 2 | 4 | 23 | 1 | 5 | 1 | .... | 1 | 3 | 7 | 9 | 5 | 6 | 15 | 82 |
| Diaphone | .... | 1 | .... | .... | 1 | 1 | .... | .... | 5 | 2 | 2 | 1 | 2 | 9 | 24 |
| Siren (electric) | .... | .... | .... | 1 | 1 | .... | .... | .... | .... | 3 | .... | .... | 1 | 4 | 10 |
| Reed horn | 8 | 6 | 7 | 4 | 4 | .... | .... | 1 | .... | .... | .... | 4 | 14 | .... | 48 |
| **Submarine bells:** | | | | | | | | | | | | | | | |
| On light vessels, driven by compressed air | 1 | 7 | 7 | .... | 6 | 3 | .... | 2 | .... | 3 | 4 | .... | 3 | 2 | 38 |
| On bottom, electric power | .... | .... | .... | .... | .... | .... | .... | .... | .... | 2 | .... | .... | .... | .... | 2 |
| On buoys, operated by sea | 1 | 1 | 2 | .... | 1 | 2 | .... | .... | .... | .... | .... | 1 | 1 | .... | 9 |
| **Bell:** | | | | | | | | | | | | | | | |
| Clockwork | 37 | 13 | 59 | 6 | 63 | 3 | 1 | 14 | 5 | 5 | 9 | 1 | 3 | 6 | 225 |
| Electric | .... | 5 | 4 | .... | 2 | .... | .... | .... | .... | 3 | .... | .... | 1 | .... | 16 |
| Engine | .... | 1 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 1 |
| Hand | 12 | 1 | 2 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 15 |
| **Horn: Hand** | .... | .... | .... | .... | .... | .... | .... | .... | .... | 1 | 1 | .... | .... | .... | 2 |
| **Total** | 70 | 48 | 111 | 12 | 88 | 12 | 1 | 19 | 16 | 56 | 61 | 12 | 35 | 42 | [a]583 |

[a] Auxiliary fog signals (71), whistling buoys (153), and bell buoys (357) are not included.

## LIGHTS ESTABLISHED DURING THE FISCAL YEAR 1919.

[186 lights.]

| District. | Location. | Order. |
|---|---|---|
| 1st | Dog Island, Me | Lens lantern (acetylene). |
| 2d | Pig Rocks, Mass | Do. |
| 3d | Sakonnet Breakwater, R. I | Do. |
|  | Barge 7 Wreck, Upper Bay, N. Y | Minor (oil gas). |
|  | Edwin R. Kirk Wreck, Upper Bay, N. Y | Lens lantern (oil gas). |
|  | Rudolph Bros. Wreck, Hudson River, N. Y | Minor (oil gas). |
|  | Mary A. Hall Wreck, Lower Bay, N. Y | Do. |
| 5th | Chicamacomico (2 lights), Pamlico Sound, N. C | Minor. |
|  | Claiborne Cut, Eastern Bay, Md | Do. |
|  | Dutch Gap, James River, Va | Lens lantern (acetylene) |
|  | J. Manco Wreck, Pamlico Sound, N. C | Minor. |
|  | North River (2 lights), N. C | Lens lantern (oil gas). |
| 6th | Dame Point (2 lights), St. Johns River, Fla | Minor. |
|  | Drum Island Channel Range (2 lights), Cooper River, S. C | Lens lantern.<br>Reflector. |
|  | Cooper River, Upper and Lower Ranges (3 lights), S. C | Lens lantern (2).<br>Reflector. |
|  | Petty Bank, St. Johns River, Fla | Minor. |
|  | Quarantine Island, Upper and Lower Ranges (3 lights), St. Johns River, Fla. | Lens lantern (2).<br>Minor. |
|  | Six-mile Creek Cut Range Front, St. Johns River, Fla | Lens lantern. |
|  | Vick Island, St. Johns River, Fla | Minor. |
| 7th | Biscayne Channel (2 lights), Fla | Do. |
|  | Cocoanut Grove, Key Biscayne Channel, Fla | Minor (acetylene). |
|  | Hanlon, Key Biscayne Bay, Fla | Minor. |
|  | Miami Side Entrance Range (2 lights), Fla | Do. |
| 9th | Caribbean Sea (3 lights) | Lens lantern (acetylene). |
| 10th | Huron Harbor, Ohio | Minor. |
|  | Lorain East Pier, Ohio | Lens lantern (acetylene). |
|  | Tempest Wreck (2 lights), Pa | Minor. |
| 11th | Grassy Point, St. Louis River, Minn | Do. |
| 12th | Chicago Harbor Entrance, South Side, Ill | Lens lantern (acetylene). |
|  | Racine North Breakwater, Wis | Do. |
|  | St. Joseph South Pierhead, Mich | Do. |
| 13th | 3 lights | Minor. |
|  | 5 lighted spars | Do. |
| 14th | 7 lights | Do. |
| 15th | 76 lights | Do. |
| 16th | Bluff Point, Behm Canal, Alaska | Do. |
|  | Blunt Point Reef, Wrangell Strait, Alaska | Do. |
|  | Boat Rock, Nakat Bay, Dixon Entrance, Alaska | Lens lantern (acetylene). |
|  | Chernofski Harbor, Unalaska Island, Alaska | Minor. |
|  | Danger Point, Chatham Strait, Alaska | Do. |
|  | Gravina Point, Prince William Sound, Alaska | Lens lantern (acetylene). |
|  | Halibut Cove, Cook Inlet (Kachemak Bay), Alaska | Minor. |
|  | Homer Spit, Cook Inlet (Kachemak Bay), Alaska | Do. |
|  | Hump Island, Clarence Strait, Alaska | Do. |
|  | Lemesurier Island, Icy Strait, North Pass, Alaska | Lens lantern (acetylene). |
|  | North Indian Pass, Icy Strait, Alaska | Do. |
|  | Point Carrew, Yakutat Bay, Alaska | Do. |
|  | Skin Island, Clarence Strait, Alaska | Minor. |
|  | South Flats Middle, Wrangell Strait, Alaska | Do. |
|  | The Brothers, Stephens Passage, Alaska | Lens lantern (acetylene). |
|  | The Eckholms, Sitka Sound, Alaska | Do. |
|  | Unalakleet (2 lights), Bering Sea, Alaska | Minor. |
|  | Washington Bay (2 lights), Chatham Strait, Alaska | Do. |
| 17th | Coquille River (6 lights), Oreg | Do. |
|  | East Waterway, Puget Sound, Wash | No lens (electric incandescent). |
|  | East Lock, Puget Sound, Wash | Lens lantern (electric incandescent). |
|  | Fisher Island, Columbia River, Wash | Minor. |
|  | Foster Island, Lake Union, Wash | Do. |
|  | Four Mile Rock, Puget Sound, Wash | Lens lantern (acetylene). |
|  | Gig Harbor, Puget Sound, Wash | Minor. |
|  | Groat Point, Lake Washington, Wash | Do. |
|  | Henrici Crossing, Columbia River, Wash | Do. |
|  | Kalama Channel (2 lights), Columbia River, Wash | Minor (electric incandescent). |
|  | Kellett Bluff, Washington Sound, Wash | Lens lantern (acetylene). |
|  | Lake Union (2 lights), Wash | Minor. |
|  | Mathews Point, Columbia River, Wash | Do. |
|  | Meydenbauer, Lake Washington, Wash | Do. |
|  | Puffin Island, Georgia Strait, Wash | Lens lantern (acetylene). |
|  | Taylor Sands, Columbia River, Wash | Minor. |
|  | Upper Guide Wall, Puget Sound, Wash | Minor (electric incandescent). |
|  | West Slip, Yaquina Bay, Oreg | Do. |
|  | West Waterway, Puget Sound, Wash | No lens (electric incandescent). |
|  | Youngs Bay, Columbia River, Oreg | Minor. |
| 18th | San Mateo, San Francisco Bay, Calif | Lens lantern (acetylene). |
|  | Alviso Channel, San Francisco Bay, Calif | Do. |
|  | Fish Harbor, Los Angeles Harbor, Calif | Do. |
| 19th | Honolulu, Fort Street, Hawaii | Minor (electric incandescent). |

## LIGHTS WHERE ILLUMINATION WAS IMPROVED DURING THE FISCAL YEAR 1919.

### FLASHING OR OCCULTING LIGHTS CHANGED FROM FIXED LIGHTS (20 LIGHTS).

| District. | Location. | District. | Location. |
|---|---|---|---|
| 2d | Egg Rock, Mass. | 12th | Chicago Harbor Breakwater, Northwest End, Ill. |
| 5th | Cape Charles City Range Front, Va. | 16th | Beck Island, Clarence Strait, Alaska. |
| | Cape Lookout Shoals Light Vessel No. 80, N. C. | | Fire Island, Cook Inlet, Alaska. |
| | Fenwick Island Shoal Light Vessel No. 52, Del. | | Port Walter, Chatham Strait, Alaska. |
| | Havre de Grace, Md. | | Skin Island, Clarence Strait, Alaska. |
| 6th | Wappoo Cut Light No. 1, S. C. | | Tree Point, Revillagigedo Channel, Alaska. |
| 11th | Clinton River Range (2 lights), Mich. | 17th | Minor Island, Juan de Fuca Strait, Wash. |
| | Copper Harbor, Mich. | | Robinson Point, Puget Sound, Wash. |
| | Pilot Island Range Front, Mich. | 18th | San Pedro Entrance, No. 2, Calif. |
| | Sand Hills, Mich. | | |

### INCANDESCENT OIL-VAPOR LIGHTS CHANGED FROM OIL-WICK LIGHTS (3 LIGHTS).

| | | | |
|---|---|---|---|
| 10th | Lorain West Breakwater Pierhead, Ohio (from acetylene). | 11th | Sand Hills, Mich. |
| | | 16th | Tree Point, Revillagigedo Channel, Alaska. |
| | | 17th | Lime Kiln, Wash. (from acetylene). |

### ACETYLENE OR OTHER LIGHTS CHANGED FROM OIL-WICK LIGHTS, ETC. (37 LIGHTS).

| | | | |
|---|---|---|---|
| 2d | Egg Rock, Mass. | 9th | Point Borinquen, P. R. (oil gas from i. o. v.). |
| | Fort Pickering, Mass. (electric incandescent). | 11th | Chicago Outer Breakwater Northwest End, Ill. (from oil gas). |
| | Nobska Point, Vineyard Sound, Mass. (electric incandescent from i. o. v.). | | Clinton River Range, (2 lights), Mich |
| 3d | Bartlett Reef Light Vessel No. 13, Conn. | | Pilot Island Range (2 lights), Mich. |
| | Craven Shoal Gas and Bell Buoy, N. Y. (from oil gas). | | Sheboygan Breakwater, Wis. (electric incandescent). |
| | Fire Island Light Vessel No. 68, N. Y. (from electric incandescent). | | White River, Mich. (electric incandescent). |
| | Overfalls Light Vessel No. 69, N. J. (from electric incandescent). | 16th | Akutan, Unimak Pass, Alaska. |
| | Scotland Light Vessel No. 11, N. J. (from oil and oil gas). | | Beck Island, Clarence Strait, Alaska. |
| 4th | Baker Range Rear, Del. | | Fire Island, Cook Inlet, Alaska. |
| | Bellevue Range Rear, Del. (from i. o. v.). | | Port Walter, Chatham Strait, Alaska. |
| | Horseshoe Range West Group Rear, Pa. (electric incandescent). | | Skin Island, Clarence Strait, Alaska. |
| 5th | Cape Lookout Shoals Light Vessel No. 80, N. C. | 17th | Alki Point, Puget Sound, Wash. (electric incandescent from i. o. v.). |
| | Havre de Grace, Md. | | Minor Island, Juan de Fuca Strait, Wash. |
| | Kettle Bottom Shoals Upper, Md. (from oil gas). | | Point Roberts, Haro Strait, Wash. |
| 6th | Wappoo Cut, S. C. | | Robinson Point, Puget Sound, Wash. (electric incandescent from i. o. v). |
| 8th | South Pass West Jetty Range Rear, Mississippi River, La. | 18th | San Pedro Entrance, No. 2, Calif. |
| | | | Point Montara, Calif. (electric incandescent from i. o. v.). |
| | | | Point Pinos, Calif. (electric incandescent from i. o. v.). |

## LIGHTS DISCONTINUED DURING THE FISCAL YEAR 1918.

[60 lights, including float lights.]

| District. | Location. | Order. |
|---|---|---|
| 3d | Barge Wreck 7, Upper Bay, N. Y. | Minor (oil gas). |
| | Edwin R. Kirk Wreck, Upper Bay, N. Y. | Lens lantern (oil gas). |
| | Rudolph Bros. Wreck, Hudson River, N. Y. | Minor (oil gas). |
| 4th | Delaware Breakwater Range Rear, Delaware Bay, Del. | 3d. |
| 5th | Dutch Gap (2 lights), James River, Va. | Minor. |
| | Curtis Bay, Patapsco River, Md. | Do. |
| | Manokin River, Md. | Minor (acetylene). |
| | North River, N. C. | 5th. |
| | St. Pierre Island, Manokin River, Md. | Minor (acetylene). |
| 6th | Dame Point Dredged Cut, St. Johns River, Fla. | Do. |
| | Dunn Creek Range (2 lights), St. Johns River, Fla. | Lens lantern. |
| | Steep Bank, St. Johns River, Fla. | Minor. |
| 10th | Tempest Wreck (2 lights), Erie Harbor, Lake Erie, Pa. | Do. |
| 12th | Racine Breakwater, Wis. | Lens lantern. |
| | St. Joseph, Mich. | 4th. |
| | Saugatuck North Pierhead, East Shore, Lake Michigan, Mich. | Lens lantern. |
| 13th | 8 lights | Minor. |
| | 1 lighted spar | Do. |
| 14th | 6 lights | Do. |
| 15th | 17 lights | Do. |
| 17th | Coquille Point, Yaquina Bay, Oreg. | Do. |
| 18th | Deadmans Island Breakwater, Los Angeles Harbor, Calif. | Lens lantern. |
| | Hookton Channel Range Rear, Humboldt Bay, Calif. | Minor. |
| | San Diego Bay (5 lights), Calif. | Lens lantern (1) (acetylene).<br>Minor (4). |
| | San Pedro Harbor, Calif. | Lens lantern. |

## GAS BUOYS ESTABLISHED AND DISCONTINUED DURING THE FISCAL YEAR 1919.

| District. | Location. |
|---|---|
| | ESTABLISHED (73). |
| 2d | Cape Ann (whistling), Mass. |
| | Governor Powers Wreck, (bell), Nantucket Sound, Mass. |
| | Lansford Wreck, Cape Cod, Mass. |
| | Mary Ann Rocks, Cape Cod, Mass. |
| | Metropolitan, Boston Harbor, Mass. |
| | South Channel, Boston Harbor, Mass. |
| 3d | Almirante Wreck, Seacoast, N. J. |
| | Barge 7 Wreck, Upper Bay, N. Y. |
| | Common Fence Point Shoal, Mount Hope Bay, R. I. |
| | Cow and Calf, Long Island Sound, Conn. |
| | Craven Shoal, (bell), Lower Bay, N. Y. |
| | Dyer Island North Point Shoal (2-1 bell) Narragansett Bay, Eastern Passage, R. I. |
| | Edwin R. Kirk, Upper Bay, N. Y. |
| | Hog Neck, Peconic Bay, N. Y. |
| | Hallocks Point Shoal, Peconic Bay, N. Y. |
| | Hen and Chickens Northeast, Long Island Sound, N. Y. |
| | Jessup Neck Shoal, Peconic Bay, N. Y. |
| | Marietta Wreck, Long Island Sound, Conn. |
| | Northport Bay Entrance, Long Island Sound, N. Y. |
| | Obstruction, off Fire Island, N. Y. |
| | Port Phillip Wreck, Lower Bay, N. Y. |
| | Parsonage Point, Long Island Sound, N. Y. |
| | Patience Island (bell), Narragansett Bay, R. I. |
| | Swept Channel, Lower Bay, N. Y. |
| | Serantes Wreck, Upper Bay, N. Y. |
| | Steamer Wreck, Seacoast, N. J. |
| | Schooner Wreck, Seacoast, N. J. |
| | San Saba Wreck, Seacoast, N. J. |
| | West Neck, Peconic Bay, N. Y. |
| 4th | Artificial Island, Delaware River, N. J. |
| | Scully Wreck (bell), Delaware Bay, Del. |
| 5th | Bush Bluff (bell), Elizabeth River, Va. |
| | Dredge Wreck (bell), Elizabeth River, Va. |
| | Guinea Marshes, 2A (bell), York River, Va. |
| | Newport News North Channel (2), Va. |
| | North River Entrance (bell), Pamlico Sound, N. C. |
| | Rappahannock Spit, Chesapeake Bay, Va. |
| | Scow Wreck, Elizabeth River, Va. |
| | Six-Fathom, Seacoast, Md. |
| | Tangier Sound Entrance, Va. |
| | Thimble Shoal Dredged Channel (4), Hampton Roads, Va. |
| | 29-Foot Lump (bell), Chesapeake Bay, Va. |
| | 30-Foot Spot, 8B, Chesapeake Bay, Va. |
| | Wolf Trap (bell), Chesapeake Bay, Va. |
| | York River (bell), Va. |
| | 30-Foot Curve (bell), Chesapeake Bay, Va. |
| | Fenwick Island Shoal, 1FIS (whistling), Del. |
| 6th | Commodore Point Shoal, St. Johns River, Fla. |
| | Drum Island, Charleston Harbor, S. C. |
| | Jupiter, Seacoast (bell), Fla. |
| | Middle Ground (bell), St. Johns River, Fla. |
| | Steel Pontoon Wreck, St. Simon Sound, Ga. |
| | Miami Entrance, Fla. |
| 7th | Sand Key Ridge West End (bell), Florida Reefs, Fla. |
| 8th | Southwest Pass Entrance (whistling), La. |

## GAS BUOYS ESTABLISHED AND DISCONTINUED DURING THE FISCAL YEAR 1919—Continued.

| District. | Location. |
|---|---|
| 10th | Buffalo Approach, Lake Erie, East End, N. Y. |
|  | North Entrance (2), Buffalo Harbor, N. Y. |
|  | Scott Point, Lake Erie, Ohio. |
| 11th | Belle Isle East End, Mich. |
|  | Marquette Breakwater, 2a, Mich. |
|  | W. R. Linn Wreck, Lake Huron, South End, Mich. |
| 12th | Desmond Wreck (bell), Calumet Harbor, Ill. |
|  | Racine North Breakwater, Wis. |
|  | Sturgeon Bay Entrance, Wis. |
| 16th | Morris Reef (bell), Alaska. |
| 18th | Crescent City Entrance (bell), Calif. |
|  | North Channel, San Francisco Bay, Calif. |
|  | DISCONTINUED (80). |
| 1st | Halibut Hole, Frenchman Bay, Me. |
|  | 25-Foot Shoal, West Penobscot Bay, Me. |
| 2d | Great Ledge, Woods Hole Harbor, Mass. |
|  | Lansford Wreck, Cape Cod, Mass. |
|  | Metropolitan, Boston Harbor, Mass. |
|  | Mosher Ledge (bell), Buzzards Bay, Mass. |
|  | South Channel (7), Boston Harbor, Mass. |
|  | Wreck Shoal, Nantucket Sound, Mass. |
| 3d | Almirante Wreck, Seacoast, N. J. |
|  | Barge 7, Upper Bay, N. Y. |
|  | Beach Channel, Rockaway Inlet, N.Y. |
|  | Common Fence Point Shoal, Mount Hope Bay, R. I. |
|  | Cow and Calf, Long Island Sound, N. Y. |
|  | Craven Shoal, Lower Bay, N. Y. |
|  | Dyer Island North Point Shoal, Narragansett Bay, R. I. |
|  | Edwin R. Kirk, Upper Bay, N. Y. |
|  | Gedney Channel (2), N. Y. |
|  | Hallocks Point Shoal, Peconic Bay, N. Y. |
|  | Hen and Chickens Northeast, Long Island Sound, N. Y. |
|  | Hog Neck, Shelter Island Sound, N. Y. |
|  | Jessup Neck, Shelter Island Sound, N. Y. |
|  | Nassau Point, Shelter Island Sound, N. Y. |
|  | Northport Bay Entrance, Long Island Sound, N. Y. |
|  | Parsonage Point, Long Island Sound, N. Y. |
|  | Patience Island (bell), Narragansett Bay, R. I. |
| 3d | Rockaway Point, Rockaway Inlet, N. Y. |
|  | San Baba Wreck, Seacoast, N. J. |
|  | Steamer Wreck, Seacoast, N. J. |
|  | Swept Channel, Lower Bay, N. Y. |
|  | West Neck, Shelter Island Sound, N. Y. |
| 4th | Baker Range, Delaware River, Del. |
|  | Marcus Hook Range, Delaware River, N. J. |
| 5th | Derrick Wreck, Elizabeth River, Va. |
|  | Dredge Wreck, Elizabeth River, Va. |
|  | Elbow of York Spit (bell), Va. |
|  | Fenwick Island Shoal, 4 F.I.S. (whistling), Del. |
|  | Georgia Wreck, Seacoast, Va. |
|  | Guinea Marshes, 2A (bell), York River, Va. |
|  | Haubage Wreck, Seacoast, Va. |
|  | Lynn Haven Roads, 3, Va. |
|  | Naval Target Wreck, Cheasapeake Bay, Va. |
|  | San Marcus Wreck (bell), Cheasapeake Bay, Va. |
|  | Scow Wreck (2), Elizabeth River, Va. |
|  | Tangier Sound Entrance, Chesapeake Bay, Va. |
|  | 29-Foot Lump, 9A (bell), Chesapeake Bay, Va. |
|  | 30-Foot Spot, 8B, Chesapeake Bay, Va. |
|  | Wolf Trap, 11A (bell), Chesapeake Bay, Va. |
|  | York River Entrance, Va. |
|  | York River (bell), Va. |
| 6th | Jupiter (bell), Seacoast, Fla. |
|  | Steel Pontoon Wreck, St. Simon Sound, Ga. |
| 8th | Galveston (2), Tex. |
|  | Southwest Pass (4, including 1 whistling and submarine bell), La. |
| 10th | Channel Shoal, Buffalo Harbor, N. Y. |
|  | Horseshoe Reef, Buffalo Harbor, N. Y |
|  | Kellys Island South Shoal, Lake Erie, Ohio. |
|  | North Entrance, Lake Erie, Buffalo Harbor, N. Y. |
| 11th | Coyle Point, St. Marys River, Mich. |
|  | W. R. Linn Wreck, Lake Huron, South End, Mich. |
| 12th | East Bank, Sturgeon Bay, Wis. |
|  | Gravelly Island Shoal (bell), Mich. |
|  | Lee Point (bell), Lake Michigan, Mich. |
|  | Northport Point (bell), Mich. |
|  | Oconto Harbor Channel (bell), Wis. |
|  | Racine North Breakwater, Wis. |
|  | Strawberry Channel Southeast, Wis. |
| 18th | San Pablo Dredged Channel (2), Calif. |

## FOG SIGNALS ESTABLISHED, IMPROVED, AND DISCONTINUED DURING THE FISCAL YEAR 1919.

| District. | Location. | Character. | |
|---|---|---|---|
| | ESTABLISHED (3). | | |
| 8th | South Pass Light Vessel, No. 102, Mississippi River, La. | 1st-class air siren. | |
| 10th | Lorain West Breakwater, Ohio. | Air diaphone. | |
| 17th | Lime Kiln, Haro Strait, Wash. | 3d-class reed horn. | |
| | IMPROVED (8). | From— | To— |
| 2d | Boston Light Station, Mass. | Steam siren. | Air siren. |
| 5th | Thimble Shoal, Chesapeake Bay, Va. | 3d-class reed horn. | Air diaphone. |
| 10th | Cleveland East Entrance, Ohio. | Electric sireno. | Do. |
| 11th | Sand Hills, Lake Superior, Mich. | Electric siren. | Do. |
| 12th | Frankfort Pierhead, Mich. | Air siren. | Do. |
| 18th | Point Arena, Calif. | Do. | Do. |
| | Point Montara, Calif. | Air whistle. | Do. |
| | Miles Rocks, Calif. | Steam whistle. | Do. |
| | DISCONTINUED (3). | | |
| 5th | Bush Bluff Light Vessel, No. 97, Elizabeth River, Va. | Bell operated by clockwork. | |
| | 35-foot Channel Light Vessel, No. 45, Chesapeake Bay, Va. | 8-inch chime whistle. | |
| 8th | Southwest Pass Light Vessel, No. 102, Mississippi River, La. | 1st-class air siren. | |

## LIGHT VESSELS ESTABLISHED AND DISCONTINUED DURING THE FISCAL YEAR 1919.

| District. | Number of vessel. | Name of station. |
|---|---|---|
| ESTABLISHED (1). | | |
| 8th | 102 | South Pass, Mississippi River, La. |
| DISCONTINUED (3). | | |
| 5th | 97 | Bush Bluff, Elizabeth River, Va. |
| | 45 | 35-Foot Channel, Chesapeake Bay, Va. |
| 8th | 102 | Southwest Pass, Mississippi River, La. |

## SUBMARINE SIGNALS DISCONTINUED DURING THE FISCAL YEAR 1919.

| District. | Location. |
|---|---|
| 5th | Thirty-Five Foot Channel Light Vessel, Chesapeake Bay, Va. |
| 8th | Southwest Pass Entrance Gas, Whistling, and Sumarine Bell Buoy, La. |

## PRIVATE AIDS TO NAVIGATION MAINTAINED ON JUNE 30, 1919.

[Under the act of June 20, 1906.]

| District. | Lights. | Buoys. | | Other unlighted aids. | Fog signals. | Total. |
|---|---|---|---|---|---|---|
| | | Lighted. | Unlighted. | | | |
| 1st | | | 34 | 2 | | 36 |
| 2d | 39 | | 30 | 12 | | 81 |
| 3d | 37 | 1 | 83 | 7 | 2 | 130 |
| 4th | | | 4 | | | 4 |
| 5th | 16 | 1 | 153 | 52 | 3 | 225 |
| 6th | 2 | 1 | 7 | | | 10 |
| 7th | 6 | | 9 | 2 | | 17 |
| 8th | 12 | | 20 | 8 | | 40 |
| 9th | | | 1 | | | 1 |
| 10th | 24 | 6 | 4 | 1 | 1 | 36 |
| 11th | 14 | 1 | 54 | 1 | | 70 |
| 12th | 32 | 2 | 8 | | 7 | 49 |
| 13th | | 1 | | | | 1 |
| 15th | 1 | | | | | 1 |
| 16th | 3 | | 1 | | | 4 |
| 17th | 2 | | 12 | | 2 | 16 |
| 18th | 26 | 2 | 7 | 1 | 11 | 47 |
| 19th | 18 | | | | | 18 |
| Total | 232 | 15 | 427 | 86 | 26 | 786 |

## BRIDGES OVER NAVIGABLE WATERS LIGHTED ON JUNE 30, 1919.

[Under the act of Aug. 7, 1882, 22 Stat., 309.]

| District. | Lighted bridges. | District, | Lighted bridges. | District. | Lighted bridges. |
|---|---|---|---|---|---|
| 1st | 22 | 8th | 261 | 15th | 8 |
| 2d | 63 | 9th | 1 | 17th | 55 |
| 3d | 214 | 10th | 64 | 18th | 30 |
| 4th | 17 | 11th | 53 | | |
| 5th | 157 | 12th | 168 | Total | 1,462 |
| 6th | 58 | 13th | 80 | | |
| 7th | 24 | 14th | 187 | | |

## AIDS MAINTAINED UNDER CONTRACT DURING FISCAL YEAR 1919.

| District. | Name of aids. | Annual cost. |
|---|---|---|
| 1st | Kennebunkport Pier Light, Me | $150.00 |
| 7th | Caximbas Pass and Big Marco Pass, Fla. (4 buoys) | 72.00 |
| 9th | Christiansted Harbor, St. Croix, Virgin Islands of U. S. (10 buoys) | 480.00 |
| 10th | Lake Ontario and the St. Lawrence River, N. Y. (41 buoys) | 3,000.00 |
| | Niagara River and Black Rock Channel, N Y. (75 buoys) | 230.00 |
| 11th | Superior Bay, St. Louis Bay and River, Wis. and Minn. (33 lights) | 3,000.00 |
| 12th | Fox River, Wis. (14 spar buoys); Green Bay, Wis. (17 spar and 2 gas buoys) | 250.00 |
| 16th | St. Michael Canal and Apoon Pass, Alaska (32 buoys), and Orizaba Reef Bell Buoy. | 428.50 |
| | Norton Sound, Alaska (11 lights) | 697.50 |

## LIGHT VESSELS IN COMMISSION DURING THE FISCAL YEAR 1919.

| Number. | Station. | District. | Tonnage. |  | When built. | Material of hull. | Dimensions. |  |  |  |  |  | Indicated horsepower (self-propelling). | Regular complement. |  | Fog signal. | Illuminant. | Cost of repairs made during fiscal year. | Cost of maintenance during fiscal year. | Original cost. | On station. |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  | Gross. | Net. |  |  | Length over all. |  | Breadth. |  | Depth. |  |  | Officers. | Crew. |  |  |  |  |  | Months. | Days. |
|  |  |  |  |  |  |  | Ft. | in. | Ft. | in. | Ft. | in. |  |  |  |  |  |  |  |  |  |  |
| 74 | Portland, Me.⊙ | 1 | [a]495 | ...... | 1902 | Wood... | 129 | 9 | 28 | 6 | 13 | 0 | 380 | 4 | 8 | 12" steam whistle [b] | Acet.... | $4,350 | $16,572 | $88,896 | 9 | 23 |
| 8 | Handkerchief, Mass.⊙ | 2 | 140 | ...... | 1852 | ...do.... | [c]69 | 4 | 23 | 0 | 10 | 0 | (d) | 2 | 5 | Bell | ...do.... | 519 | 8,774 | 12,000 | 8 | 29 |
| 4 | Relief⊙ | 2 | 104 | ...... | 1855 | ...do.... | [c]77 | 0 | 20 | 0 | 10 | 0 | (d) | 1 | 0 | Bell or horn | Oil...... | 24 | 1,512 | ........ | 8 | 5 |
| 5 | Stone Horse Shoal, Mass.⊙ | 2 | 104 | ...... | 1864 | ...do.... | [c]80 | 6 | 21 | 6 | 9 | 0 | (d) | 2 | 7 | 8" air whistle | ...do.... | 1,734 | 10,858 | ........ | 7 | 25 |
| 20 | Cross Rip, Mass | 2 | 165 | ...... | 1867 | ...do.... | [c]81 | 6 | 21 | 6 | 10 | 0 | (d) | 2 | 5 | Bell | Acet.... | 335 | 10,520 | 25,040 | 12 | .... |
| 9 | Hedge Fence, Mass | 2 | 104 | ...... | 1857 | ...do.... | [c]81 | 2 | 28 | 2 | 9 | 6 | (d) | 2 | 7 | 8" air whistle [b] | Oil...... | 1,716 | 10,348 | 19,883 | 11 | 10 |
| 41 | Vineyard Sound, Mass.⊙ | 2 | 387 | ...... | 1876 | ...do.... | 120 | 6 | 26 | 9 | 11 | 0 | (d) | 2 | 7 | First-class air siren [b] | ...do.... | 5,750 | 12,973 | 33,000 | 8 | 23 |
| 42 | Hen and Chickens, Mass.⊙ | 2 | 410 | ...... | 1877 | ...do.... | 121 | 7 | 26 | 6 | 10 | 6 | (d) | 3 | 7 | 10" air whistle | ...do.... | 7,361 | 12,329 | 40,796 | 8 | 11 |
| 47 | Pollock Rip, Mass.⊙ | 2 | [a]470 | ...... | 1891 | Comp... | 120 | 10 | 26 | 6 | 11 | 0 | (d) | 4 | 6 | 12" steam chime wh. [b] | ...do.... | 1,764 | 13,458 | 60,000 | 9 | 16 |
| 54 | Boston, Mass.⊙ | 2 | 310 | ...... | 1892 | Steel.... | 118 | 10 | 26 | 0 | 11 | 0 | 150 | 4 | 7 | First-class air siren [b] | Inc. o.v. | 954 | 15,393 | 62,030 | 11 | 11 |
| 66 | Great Round Shoal, Mass.⊙ | 2 | [a]590 | ...... | 1896 | Comp... | 123 | 0 | 28 | 6 | 13 | 0 | 350 | 4 | 8 | 12" steam chime wh. [b] | Acet.... | 242 | 16,230 | 69,282 | 12 | .... |
| 73 | Pollock Rip Slue, Mass.⊙ | 2 | [a]538 | ...... | 1901 | Steel.... | 123 | 9 | 28 | 6 | 12 | 9 | 400 | 4 | 8 | .....do. [b] | Oil...... | 3,278 | 15,085 | 79,872 | 10 | 28 |
| 85 | Nantucket Shoals, Mass.⊙ | 2 | [a]683 | 246 | 1907 | ...do.... | 135 | 5 | 29 | 0 | 13 | 0 | 380 | 5 | 10 | .....do. [b] | El. inc.. | 3,574 | 23,965 | 99,000 | 8 | 9 |
| 86 | Relief⊙ | 2 | [a]683 | 246 | 1907 | ...do.... | 135 | 5 | 29 | 0 | 13 | 0 | 380 | 4 | 6 | .....do. [b] | Oil...... | 1,945 | 14,262 | 99,000 | 7 | 20 |
| 90 | Relief⊙ | 2 | [a]685 | 225 | 1908 | ...do.... | 135 | 5 | 29 | 6 | 13 | 0 | 400 | 4 | 6 | .....do. [b] | ...do.... | 1,154 | 14,737 | 107,213 | 7 | 22 |
| 11 | Scotland, N. J.⊙ | 3 | 320 | ...... | 1853 | Wood... | [c]104 | 0 | 24 | 8 | 11 | 6 | (d) | 2 | 5 | Bell | Oil and oil gas. | 3,307 | 8,646 | 13,462 | 11 | 13 |
| 13 | Bartlett Reef, Conn | 3 | 155 | ...... | 1854 | ...do.... | [c]79 | 8 | 21 | 8 | 10 | 4 | (d) | 4 | 5 | .....do | Oil...... | 24,927 | 11,924 | 12,000 | 2 | 23 |
| 16 | Relief⊙ | 3 | 250 | ...... | 1854 | ...do.... | [c]103 | 6 | 22 | 6 | 11 | 0 | (d) | 1 | 1 | First-class air siren, 6" whistle. [b] | ...do... | 6,225 | 3,257 | 28,084 | 10 | 17 |
| 23 | Ram Island Reef, Conn.⊙ | 3 | 186 | ...... | 1857 | ...do.... | [c]94 | 2 | 24 | 0 | 9 | 0 | (d) | 2 | 5 | 10" air | ...do.... | 3,584 | 8,456 | 7,500 | 10 | 9 |
| 39 | Brenton Reef, R. I.⊙ | 3 | 387 | ...... | 1875 | ...do.... | 119 | 6 | 26 | 9 | 13 | 0 | (d) | 4 | 6 | 10" and 6" steam wh. [b] | ...do.... | 210 | 12,660 | 42,200 | 12 | .... |
| 44 | Northeast End, N. J.⊙ | 3 | 197 | ...... | 1882 | Iron.... | 115 | 6 | 25 | 0 | 10 | 6 | (d) | 4 | 8 | First-class steam siren [b] | Acet.... | 1,802 | 13,733 | 50,000 | 10 | 15 |
| 48 | Cornfield Point, Conn.⊙ | 3 | [a]470 | ...... | 1891 | Comp... | 120 | 10 | 27 | 8 | 12 | 0 | (d) | 4 | 6 | ....do. [b] | Acet. and oil. | 1,424 | 12,721 | 52,780 | 9 | 20 |
| 51 | Relief [k] | 3 | 283 | ...... | 1892 | Iron..... | 118 | 10 | 26 | 9 | 11 | 0 | 135 | 2 | 6 | 12" steam whistle [b] | El. inc.. | 392 | 8,944 | 53,325 | 3 | 10 |
| 68 | Fire Island, N. Y.⊙ | 3 | [a]590 | 204 | 1897 | Comp... | 122 | 10 | 28 | 6 | 12 | 6 | 350 | 4 | 10 | 12" steam chime wh. [b] | ...do.... | 6,383 | 17,350 | 74,750 | 9 | 27 |
| 69 | Overfalls, Del.⊙ | 3 | [a]590 | 204 | 1897 | ...do.... | 122 | 10 | 29 | 6 | 13 | 0 | 350 | 4 | 10 | .....do. [b] | ...do.... | 1,069 | 16,334 | 79,500 | 10 | 1 |
| 78 | Relief⊙ | 3 | [a]668 | 188 | 1904 | Steel.... | 129 | 0 | 28 | 6 | 12 | 6 | 325 | 4 | 6 | 12" steam whistle [b] | Oil or acet. | 5,119 | 11,865 | 89,030 | 8 | 11 |
| 79 | Five-Fathom Bank, N. J.⊙ | 3 | [a]668 | 188 | 1904 | ...do.... | 129 | 0 | 28 | 6 | 12 | 6 | 325 | 4 | 8 | 12" steam chime wh. [b] | Oil...... | 2,463 | 15,780 | 89,000 | 10 | 9 |
| 87 | Ambrose Channel, N. Y.⊙ | 3 | [a]683 | 246 | 1907 | ...do.... | 135 | 5 | 29 | 0 | 13 | 0 | 325 | 4 | 10 | 12" steam whistle [b] | E. arc... | 398 | 19,680 | 99,000 | 10 | 30 |

| | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | Relief | 5 | 210 | ...... | 1849 | Wood | [c]98 | 0 | 25 | 0 | 9 | 0 | (d) | 1 | 5 | Bell | Oil | 7,174 | 5,795 | 12,402 | 2 | .... |
| 45 | Thirty-Five Foot Channel, Va.[g] | 5 | [a]401 | 285 | 1887 | Steel[f] | 124 | 6 | 27 | 6 | 12 | 0 | (d) | .... | 2 | 8" air chime whistle[b] | ...do | 340 | 1,273 | 58,500 | .... | .... |
| 46 | Tail of the Horseshoe, Va.⊙ | 5 | [a]401 | ...... | 1887 | ...do.[f] | 124 | 6 | 27 | 6 | 12 | 0 | (d) | 4 | 6 | 12" steam whistle[b] | ...do | 4,121 | 13,631 | 60,000 | 10 | 5 |
| 49 | Relief⊙ | 5 | [a]470 | ...... | 1890 | Comp | 120 | 10 | 27 | 0 | 14 | 0 | (d) | 4 | 6 | First-class air siren[b] | Acet | 18,268 | 12,618 | 57,900 | 4 | 18 |
| 52 | Fenwick Island Shoal, Del.⊙ | 5 | [a]416 | ...... | 1892 | Iron | 118 | 10 | 26 | 6 | 12 | 0 | 180 | 4 | 9 | ....do.[b] | ...do | 9,988 | 18,666 | 62,000 | 10 | 19 |
| 71 | Diamond Shoal, N. C.[e] ⊙ | 5 | [a]590 | 204 | 1897 | Comp | 122 | 10 | 28 | 6 | 13 | 0 | 350 | 5 | 10 | 12" steam chime wh.[b] | El. inc | 190 | 2,613 | 70,700 | .... | 37 |
| 72 | Relief[e] ⊙ | 5 | [a]693 | ...... | 1900 | Steel | 123 | 6 | 28 | 6 | 14 | 0 | 350 | 5 | 10 | ....do.[b] | ...do | 24,167 | 22,425 | 89,000 | 8 | 10 |
| 80 | Cape Lookout Shoals, N. C.⊙ | 5 | [a]668 | 188 | 1904 | ...do | 129 | 0 | 28 | 6 | 12 | 6 | 500 | 4 | 10 | ....do.[b] | Oil | 11,126 | 20,087 | 85,000 | 10 | 5 |
| 91 | Winter Quarter Shoal, Va.⊙ | 5 | [a]685 | 225 | 1908 | ...do | 135 | 5 | 29 | 0 | 13 | 0 | 400 | 4 | 10 | ....do.[b] | Acet | 6,904 | 21,367 | 107,213 | 10 | 19 |
| 97 | Bush Bluff, Va.[g] | 5 | 87 | ...... | 1876 | Comp | 80 | 6 | 19 | 5 | 12 | 0 | (h) | .... | .... | Bell | Oil gas | ........ | 627 | ........ | 1 | 21 |
| 101 | Cape Charles, Va.⊙ | 5 | [a]360 | ...... | 1916 | Steel | 101 | 10 | 25 | 0 | 13 | 2 | 200 | 4 | 7 | First-class air siren[b] | Acet | 3,704 | 15,603 | 108,507 | 8 | .... |
| 1 | Martins Industry, S. C.⊙ | 6 | 275 | ...... | 1855 | Wood | [c]103 | 0 | 24 | 0 | 13 | 0 | (d) | 2 | 8 | ....do.[b] | Oil | 5,583 | 12,598 | ........ | 9 | 23 |
| 34 | Charleston, S. C.⊙ | 6 | 150 | ...... | 1864 | ...do | 101 | 10 | 23 | 0 | 10 | 0 | (d) | 2 | 7 | Air diaphone | Acet | 74 | 9,851 | 48,000 | 8 | 24 |
| 53 | Relief⊙ | 6 | 310 | ...... | 1892 | Iron | 119 | 0 | 26 | 6 | 11 | 0 | 135 | 4 | 9 | 12" steam whistle[b] | ...do | 3,226 | 17,680 | 61,538 | 8 | 23 |
| 84 | Brunswick, Ga.⊙ | 6 | [a]683 | 246 | 1907 | Steel | 135 | 5 | 29 | 0 | 13 | 0 | 325 | 4 | 10 | ....do.[b] | Oil | 7,124 | 19,597 | 99,000 | 9 | 11 |
| 94 | Frying Pan Shoals, N. C.⊙ | 6 | [a]670 | 229 | 1911 | ...do | 135 | 6 | 29 | 0 | 13 | 0 | 363 | 4 | 10 | 12" steam chime wh.[b] | Inc. o. v. | 510 | 17,193 | 104,604 | 11 | 10 |
| 43 | Relief | 8 | 191 | 110 | 1881 | Comp | 118 | 0 | 25 | 0 | 12 | 0 | (d) | 4 | 6 | ....do.[b] | Oil | ........ | 1,224 | 50,000 | .... | .... |
| 81 | Heald Bank, Tex.⊙ | 8 | [a]668 | 188 | 1904 | Steel | 129 | 0 | 28 | 6 | 12 | 6 | 325 | 4 | 8 | ....do.[b] | ...do | 4,060 | 16,755 | 90,000 | 8 | 3 |
| 102 | South Pass, La.⊙ | 8 | [a]360 | ...... | 1916 | ...do | 101 | 10 | 25 | 0 | 13 | 2 | 200 | 4 | 7 | First-class air siren[b] | Inc. o. v. | 1,791 | 14,282 | 110,065 | 8 | 12 |
| 61 | Lake Huron, Mich | 11 | 105 | 101 | 1893 | Wood | 87 | 2 | 21 | 0 | 9 | 0 | (d) | 3 | 3 | 6" steam whistle[b] | Oil | 255 | 7,137 | 14,098 | 6 | 14 |
| 62 | Bar Point Shoal, Mich | 11 | 105 | 101 | 1893 | ...do | 87 | 2 | 21 | 6 | 8 | 0 | (d) | 3 | 3 | ....do | ...do | 490 | 7,072 | 14,098 | 7 | 27 |
| 75 | Lake St. Clair, Mich | 11 | 160 | ...... | 1902 | Steel | 83 | 9 | 24 | 0 | 4 | 9 | (d) | 2 | 2 | Bell | ...do | 395 | 4,517 | 14,998 | 8 | 7 |
| 82 | Relief | 11 | [i]209 | 61 | 1912 | ...do | 95 | 2 | 21 | 0 | 8 | 11 | 90 | 4 | 3 | 10" steam whistle[b] | Acet | 856 | 9,176 | 42,910 | 2 | 3 |
| 89 | Martin Reef, Mich | 11 | [i]205 | 76 | 1908 | ...do | 88 | 3 | 21 | 0 | 10 | 0 | 90 | 4 | 3 | 6" steam whistle[b] | Oil | 407 | 7,621 | 37,500 | 7 | 21 |
| 96 | Poe Reef, Mich | 11 | [i]170 | ...... | 1914 | ...do | 101 | 0 | 23 | 6 | 11 | 5 | (h) | 3 | 4 | First-class air siren[b] | El. inc | 782 | 7,090 | 71,292 | 8 | 4 |
| 55 | Lansing Shoal, Mich | 12 | 129 | 100 | 1891 | Wood | 102 | 8 | 20 | 0 | 9 | 0 | 100 | 4 | 2 | 6" steam whistle[b] | Oil | 307 | 6,984 | 13,600 | 6 | 1 |
| 56 | North Manitou Shoal, Mich | 12 | 130 | 101 | 1891 | ...do | 102 | 8 | 20 | 0 | 8 | 10 | 100 | 4 | 2 | ....do.[b] | ...do | 13 | 8,112 | 13,600 | 7 | 27 |
| 57 | Grays Reef, Mich | 12 | 130 | 101 | 1891 | ...do | 102 | 8 | 20 | 0 | 8 | 10 | 100 | 4 | 2 | ....do.[b] | ...do | 339 | 8,404 | 13,600 | 7 | 28 |
| 60 | Eleven-Foot Shoal, Mich | 12 | 105 | 101 | 1893 | ...do | 87 | 2 | 21 | 6 | 8 | 6 | (d) | 3 | 3 | 10" steam whistle[b] | ...do | 182 | 6,502 | 13,990 | 7 | 12 |
| 77 | Peshtigo Reef, Wis | 12 | [i]155 | ...... | 1906 | Steel | 75 | 0 | 21 | 6 | 4 | 0 | (d) | 2 | 3 | 8" air chime whistle | ...do | 262 | 5,866 | 13,950 | 7 | 13 |
| 95 | Milwaukee, Wis | 12 | [i]368 | 156 | 1912 | ...do | 108 | 5 | 23 | 0 | 10 | 2 | 200 | 4 | 5 | 12" steam whistle | El. inc | 1,401 | 13,650 | 74,558 | 10 | 1 |
| 98 | Relief | 12 | [i]195 | ...... | 1915 | ...do | 101 | 0 | 23 | 6 | 11 | 5 | 100 | 4 | 2 | First-class air siren[b] | ...do | 1,626 | 7,070 | 87,025 | 3 | 25 |
| 67 | Umatilla Reef, Wash | 17 | 450 | 364 | 1897 | Comp | 122 | 7 | 28 | 6 | 13 | 0 | 200 | 4 | 11 | 12" steam whistle[b] | Oil | 127 | 20,052 | 69,750 | 10 | 2 |
| 88 | Columbia River, Oreg | 17 | [a]683 | 246 | 1907 | Steel | 135 | 5 | 29 | 0 | 13 | 0 | 325 | 4 | 11 | ....do.[b] | ...do | 2,434 | 21,273 | 90,000 | 9 | 6 |
| 92 | Relief | 17 | [a]685 | 225 | 1908 | ...do | 135 | 5 | 29 | 0 | 13 | 0 | 400 | 2 | 5 | ....do.[b] | ...do | 4,279 | 20,036 | 107,213 | 9 | 8 |
| 93 | Swiftsure Bank, Wash | 17 | [a]685 | 225 | 1908 | ...do | 135 | 5 | 29 | 0 | 13 | 0 | 400 | 4 | 11 | ....do.[b] | ...do | 5,030 | 22,036 | 107,213 | 7 | 25 |
| 70 | San Francisco, Cal.⊙ | 18 | [a]590 | ...... | 1897 | Comp | 122 | 10 | 28 | 6 | 13 | 0 | 349 | 4 | 11 | ....do.[b] | El. inc | 3,233 | 20,659 | 79,000 | 10 | 20 |
| 76 | Relief | 18 | [a]578 | 169 | 1904 | Steel | 129 | 6 | 28 | 8 | 12 | 0 | 380 | 2 | 5 | ....do.[b] | Oil | 1,549 | 16,116 | 90,000 | 5 | 4 |
| 83 | Blunts Reef, Cal.⊙ | 18 | [a]663 | 188 | 1904 | ...do | 129 | 0 | 28 | 6 | 13 | 0 | 380 | 4 | 11 | ....do.[b] | ...do | 803 | 21,571 | 90,000 | 8 | 14 |

[a] Displacement (salt water).
[b] Submarine signal.
[c] Length between perpendiculars.
[d] Sail.
[e] Sunk by enemy submarine Aug. 6, 1918.
[f] Wood sheathed.
[g] Laid up.
[h] No means of propulsion.
[i] Displacement (fresh water).
⊙ Equipped with radio.
[k] Sunk in collision Apr. 24, 1919.
[l] Replaced; Light Vessel, No. 71.

## TENDERS OF LIGHTHOUSE SERVICE IN COMMISSION DURING THE FISCAL YEAR 1919.

| Name. | District. | Displacement. |  | When built. | Description. | Material of hull. | Dimensions. |  |  | Mean draft. |  | Indicated horsepower. | Regular complement. |  | Miles steamed. | Coal consumed for all purposes. | Cost of repairs. | Cost of maintenance. | Original cost. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  | Light.[a] | Loaded.[b] |  |  |  | Length over all. | Breadth. | Depth. | Light.[a] | Loaded.[b] |  | Officers. | Crew. |  |  |  |  |  |
|  |  | *Tons.* | *Tons.* |  |  |  | *Feet.* | *Feet.* | *Feet.* | *Ft. in.* | *Ft. in.* |  |  |  |  | *Tons.* |  |  |  |
| Hibiscus⊙...... | 1 | 818 | 1,081 | 1908 | Steamer, twin screw... | Steel.. | 190 | 30 | 16 | 11 0 | 13 3 | 1,000 | 7 | 26 | 14,779 | 2,126 | $12,289 | $57,067 | $184,643 |
| Zizania⊙....... | 1 | 575 | 643 | 1888 | .....do................ | Iron... | 161 | 27 | 12 | 8 9 | 9 6 | 650 | 6 | 22 | 9,219 | 875 | 752 | 42,463 | 48,739 |
| Anemone⊙..... | 2 | 818 | 1,053 | 1908 | .....do................ | Steel.. | 190 | 30 | 16 | 11 0 | 13 0 | 1,000 | 7 | 26 | 12,544 | 1,581 | 7,921 | 46,370 | 191,999 |
| Azalea⊙........ | 2 | 330 | 516 | 1891 | Steamer, single screw.. | ...do... | 154 | 25 | 12 | 6 6 | 9 0 | 400 | 6 | 22 | 9,411 | 800 | 6,763 | 40,610 | 79,792 |
| Mayflower⊙.... | 2 | 630 | 668 | 1897 | Steamer, twin screw... | ...do... | 164 | 30 | 12 | 7 9 | 8 1 | 650 | 6 | 24 | 10,190 | 1,563 | 10,496 | 49,557 | 74,872 |
| Daisy........... | 3 | 61 | 84 | 1892 | Steamer, single screw.. | Wood. | 80 | 14 | 5 | 4 0 | 5 0 | 60 | 2 | 5 | 5,451 | 127 | 2,185 | 9,092 | 6,500 |
| Gardenia [c]...... | 3 | 217 | 245 | 1879 | .....do................ | ...do... | [d]117 | 20 | 9 | 6 0 | 6 6 | 200 | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| John Rodgers... | 3 | 455 | 571 | 1883 | Steamer, side wheel... | Iron... | 160 | 27 | 9 | 6 6 | 7 9 | 260 | 4 | 17 | 7,294 | 595 | 1,077 | 29,734 | 59,987 |
| Larkspur⊙..... | 3 | 738 | 888 | 1903 | Steamer, twin screw... | Steel.. | 169 | 30 | 14 | 9 1 | 10 6 | 750 | 7 | 24 | 13,757 | 2,277 | 2,121 | 53,298 | 123,259 |
| Mistletoe....... | 3 | 455 | 476 | 1872 | Steamer, side wheel... | Wood. | 160 | 26 | 9 | 6 9 | 7 0 | 370 | 4 | 16 | 5,697 | 570 | 4,300 | 27,010 | 45,833 |
| Pansy.......... | 3 | 431 | 454 | 1878 | Steamer, twin screw... | Iron... | 152 | 25 | 11 | 7 7 | 7 11 | 250 | 4 | 17 | 6,326 | 743 | 2,486 | 30,209 | 48,739 |
| Tulip⊙........ | 3 | 774 | 1,142 | 1908 | .....do................ | Steel.. | 190 | 30 | 16 | 10 7 | 13 9 | 1,000 | 7 | 26 | 18,423 | 2,032 | 9,433 | 54,496 | 191,658 |
| Myrtle.......... | 3 | 435 | 542 | 1872 | Steamer, single screw.. | Wood. | 140 | 25 | 11 | 9 6 | 11 0 | 225 | 4 | 16 | 16,067 | 922 | 3,000 | 32,651 | 44,500 |
| Elm............ | 3 | 259 | 318 | 1918 | Oil, single screw....... | ...do... | 101 | 30 | 9 | 5 6 | 6 9 | 150 | 2 | 4 | ........ | ........ | 854 | 2,690 | 93,638 |
| Pine........... | 3 | 55 | 56 | 1918 | Gasoline, single screw. | ...do... | 61 | 15 | 6 | 4 3 | 4 4 | 50 | 2 | 3 | 951 | 765 | 16,903 | 3,493 | 16,187 |
| Iris............. | 4 | 519 | 606 | 1897 | Steamer, single screw.. | Steel.. | 153 | 30 | 10 | 8 7 | 9 6 | 800 | 5 | 20 | 9,026 | 1,082 | 1,888 | 29,931 | 84,407 |
| Woodbine...... | 4 | 85 | 107 | 1913 | Gasoline, single screw. | Wood. | 95 | 16 | 7 | 5 2 | 5 11 | 125 | 2 | 5 | 6,468 | 10<br>[a]12,859 | 408 | 14,931 | 24,728 |
| Columbine⊙.... | 5 | 429 | 643 | 1892 | Steamer, single screw.. | Steel.. | 155 | 27 | 15 | 9 6 | 12 3 | 800 | 7 | 23 | 9,945 | 1,095 | 5,627 | 43,168 | 58,238 |
| Arbutus⊙...... | 5 | 398 | 545 | 1879 | Steamer, twin screw... | Wood. | 153 | 25 | 11 | 7 1 | 9 0 | 360 | 7 | 22 | 8,112 | 964 | 29,094 | 44,233 | 49,769 |
| Holly.......... | 5 | 431 | 499 | 1881 | Steamer, side wheel... | Comp. | 176 | 24 | 10 | 7 0 | 8 6 | 400 | 5 | 18 | 8,997 | 732 | 1,281 | 39,070 | 41,911 |
| Jessamine...... | 5 | 369 | 403 | 1881 | .....do................ | Iron... | 156 | 24 | 10 | 7 3 | 7 9 | 350 | 4 | 18 | 8,094 | 754 | 1,537 | 35,771 | 41.911 |
| Juniper......... | 5 | 125 | 146 | 1903 | Steamer, twin screw... | Steel.. | 95 | 18 | 8 | 4 6 | 5 0 | 290 | 2 | 9 | 9,398 | 628 | 9,999 | 19,379 | 29,425 |
| Laurel.......... | 5 | 218 | 299 | 1915 | Steamer, single screw.. | Wood. | 105 | 22 | 9 | 6 1 | 6 10 | 160 | 4 | 12 | 11,257 | 450 | 466 | 29,120 | 55,502 |
| Maple.......... | 5 | 567 | 799 | 1893 | Steamer, twin screw... | Steel.. | 164 | 30 | 12 | 7 3 | 9 5 | 650 | 7 | 24 | 7,328 | 884 | 810 | 48,333 | 93,889 |
| Orchid⊙....... | 5 | 818 | 1,081 | 1908 | .....do................ | ...do... | 190 | 30 | 16 | 11 0 | 13 3 | 1,000 | 7 | 27 | 16,068 | 2,196 | 3,443 | 61,538 | 186,151 |
| Cypress⊙....... | 6 | 790 | 1,080 | 1908 | .....do................ | ...do... | 190 | 30 | 16 | 10 9 | 13 3 | 1,000 | 7 | 26 | 18,419 | 2,434 | *5,331 | *28,499 | 191,633 |
| Mangrove....... | 6 | 606 | 821 | 1897 | .....do................ | ...do... | 164 | 30 | 12 | 7 6 | 9 6 | 550 | 6 | 24 | ........ | ........ | *72,700 | *3,902 | 74,998 |

| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Palmetto | 6 | 156 | 170 | 1917 | Gasoline, twin screw | ...do... | 90 | 22 | 8 | 3 | 8 | 4 | 0 | 150 | 4 | 8 | 6,301 | 11<br>[e]14,493 | 3,541 | 21,194 | 27,687 |
| Water Lily | 6 | 29 | 39 | 1895 | .....do | Wood. | 64 | 11 | 5 | 2 | 11 | 3 | 8 | 36 | 2 | 3 | 6,092 | 5<br>[e]3,813 | 371 | 8,026 | 9,261 |
| Ivy⊙ | 7 | 736 | 916 | 1904 | Steamer, twin screw | Steel | 173 | 30 | 13 | 8 | 5 | 9 | 6 | 700 | 6 | 24 | 11,355 | 1,890 | 3,715 | 55,231 | 123,860 |
| Snowdrop | 7 | 30 | 41 | 1896 | Gasoline, twin screw | Wood. | 69 | 11 | 5 | 2 | 10 | 3 | 7 | 32 | 2 | 2 | 4,907 | [e]4,700 | 2,027 | 8,305 | 9,700 |
| Poinsettia | 7 | 27 | 31 | 1915 | Gasoline, single screw | ...do... | 50 | 16 | 6 | 2 | 5 | 2 | 9 | 50 | 2 | 2 | 104 | [e]180 | 15 | 668 | ......... |
| Camellia | 8 | 276 | 377 | 1911 | Steamer, twin screw | Steel | 117 | 24 | 10 | 5 | 10 | 7 | 7 | 280 | 4 | 17 | 6,539 | 646 | 166 | 31,447 | 57,412 |
| Magnolia⊙ | 8 | 685 | 877 | 1904 | .....do | ...do... | 173 | 30 | 13 | 7 | 6 | 9 | 2 | 700 | 6 | 25 | 7,497 | 1,061 | *263 | *43,739 | 124,874 |
| Sunflower⊙ | 8 | 806 | 1,246 | 1907 | .....do | ...do... | 174 | 31 | 15 | 10 | 5 | 14 | 6 | 900 | 7 | 27 | 10,465 | 1,433 | 100 | 6,466 | 124,958 |
| Cosmos | 8 | 57 | 61 | 1909 | Gasoline, twin screw | Wood. | 75 | 15 | 6 | 3 | 9 | 4 | 0 | 100 | 1 | 4 | ....... | ....... | ....... | ......... | ......... |
| Lilac | 9 | 542 | 582 | 1892 | Steamer, single screw | Steel | 155 | 27 | 15 | 11 | 0 | 11 | 6 | 800 | 6 | 19 | 5,458 | 636 | 4,523 | 41,115 | 92,125 |
| Crocus | 10 | [f]681 | 1,035 | 1904 | Steamer, twin screw | ...do... | 165 | 29 | 14 | 9 | 6 | 12 | 3 | 700 | 5 | 23 | 7,587 | 1,590 | 4,096 | 46,466 | 119,718 |
| Amaranth | 11 | [f]597 | [f]975 | 1892 | Steamer, single screw | ...do... | 166 | 28 | 14 | 8 | 6 | 12 | 6 | 672 | 5 | 20 | 11,729 | 1,250 | 2,382 | 42,912 | 74,994 |
| Aspen | 11 | [f]353 | [f]415 | 1906 | .....do | ...do... | 126 | 25 | 12 | 7 | 3 | 8 | 3 | 440 | 4 | 10 | 6,324 | 653 | 1,491 | 24,070 | 70,573 |
| Clover | 11 | [f]163 | [f]205 | 1899 | .....do | Wood. | 93 | 22 | 7 | 5 | 4 | 6 | 4 | 140 | 4 | 8 | 10,362 | 403 | 893 | 17,953 | ......... |
| Marigold | 11 | [f]477 | [f]696 | 1890 | .....do | Iron | 160 | 27 | 12 | 8 | 5 | 11 | 0 | 550 | 5 | 20 | 9,745 | 842 | 18,934 | 39,242 | 84,871 |
| Hyacinth | 12 | [f]493 | [f]914 | 1903 | .....do | Steel | 165 | 28 | 14 | 7 | 0 | 11 | 6 | 768 | 5 | 20 | 10,338 | 1,484 | 2,061 | 44,050 | 115,000 |
| Sumac⊙ | 12 | [f]600 | [f]887 | 1903 | Steamer, twin screw | ...do... | 169 | 30 | 13 | 8 | 10 | 11 | 9 | 700 | 6 | 23 | 11,523 | 1,543 | 2,816 | 45,836 | 114,992 |
| Dandelion | 13 | [f]232 | [f]302 | 1893 | Steamer, stern wheel | Wood. | 140 | 31 | 5 | 2 | 6 | 3 | 3 | 500 | 4 | 15 | 5,853 | 1,126 | 4,945 | 26,156 | 23,174 |
| Goldenrod | 14 | [f]194 | [f]283 | 1888 | .....do | Steel | 169 | 27 | 4 | 2 | 5 | 3 | 4 | 152 | ...... | ...... | ....... | ....... | ....... | ......... | 33,221 |
| Oleander | 15 | [f]463 | [f]548 | 1903 | .....do | ...do... | 189 | 34 | 7 | 3 | 10 | 4 | 6 | 600 | 4 | 17 | 11,156 | 1,787 | 3,366 | 35,763 | 60,000 |
| Fern ⊙ | 16 | 245 | 317 | 1915 | Steamer, single screw | Wood. | 112 | 22 | 10 | | 1 | 8 | 6 | 300 | 5 | 11 | 10,910 | [g]1,992 | 4,949 | 30,176 | 62,100 |
| Cedar⊙ | 16 | 1,245 | 1,970 | 1917 | .....do | Steel | 201 | 36 | 18 | 9 | 6 | 14 | 0 | 1,150 | 8 | 25 | 14,839 | [g]11,730 | 7,098 | 93,642 | 248,189 |
| Heather⊙ | 17 | 631 | 831 | 1903 | .....do | ...do... | 179 | 28 | 15 | 9 | 6 | 11 | 6 | 685 | 7 | 20 | 9,209 | 1,836 | 661 | 47,512 | 118,568 |
| Manzanita⊙ | 17 | 774 | 1,000 | 1908 | Steamer, twin screw | ...do... | 190 | 30 | 16 | 10 | 7 | 12 | 7 | 1,000 | 7 | 23 | 8,816 | 2,012 | 3,380 | 54,861 | 211,817 |
| Rose⊙ | 17 | 395 | 567 | 1916 | .....do | ...do... | 127 | 24 | 11 | 7 | 0 | 9 | 4 | 330 | 5 | 16 | 8,426 | [g]389 | 1,264 | *3,433 | 92,135 |
| Madrono⊙ | 18 | 654 | 806 | 1885 | Steamer, single screw | Iron | 180 | 27 | 15 | 9 | 9 | 11 | 6 | 750 | 7 | 20 | 9,399 | 1,175 | *16,885 | *21,612 | 87,872 |
| Sequoia⊙ | 18 | 809 | 1,100 | 1908 | Steamer, twin screw | Steel | 190 | 30 | 16 | 10 | 11 | 13 | 5 | 1,000 | 7 | 23 | 10,994 | 1,475 | *1,270 | *20,698 | 213,499 |
| Kukui⊙ | 19 | 838 | 935 | 1908 | .....do | ...do... | 190 | 30 | 16 | 11 | 2 | 12 | 0 | 1,000 | 7 | 23 | 10,653 | 1,543 | 2,396 | 64,613 | 213,880 |

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[a] Light=without cargo and deck loads, and a minimum supply of stores, provisions, water, and coal or oil.

[b] Loaded=bunkers or fuel-oil tanks full of coal or oil, all tanks, including trimming tanks, full of water; full stores and provisions, and an average maximum cargo and deck load.

[c] Condemned.

[d] Length between perpendiculars.

[e] Gallons gasoline.

⊙ Equipped with radio

[f] Displacement (fresh water).

[g] Barrels of fuel oil. 1 barrel=42 gallons.

* Amounts for maintenance and repairs paid direct by Navy Department not included in figures shown.

## CONSTRUCTION OF TENDERS AND LIGHT VESSELS.

*Tender "Aster" and barge.*—The act of July 1, 1916, appropriated $20,000 for constructing or purchasing and equipping a small tender and barge for the eighth district, Texas and Louisiana. It was proposed to purchase a suitable vessel for a tender and construct the barge from plans and specifications now in preparation. Bids were twice invited for the purchase of a suitable tender without satisfactory results owing to the scarcity of vessels caused by war conditions. Design for a suitable type of vessel has been secured from which plans and specifications for a tender are now being prepared. Amount expended to June 30, 1919, $13.14.

*Tender "Elm."*—The act of July 1, 1916, appropriated $100,000 for aids to navigation, Hudson River, N. Y. It was found that in the construction of these aids a light-draft power barge, with derrick, was required. A suitable barge available for purchase could not be found, and accordingly plans and specifications were prepared for a wooden, power, derrick barge, and on January 13, 1917, a contract was awarded to Rice Bros., East Boothbay, Me., for the construction of the hull, in the sum of $29,400. The keel, stem, sternpost, and frames were partly completed when, on July 10, 1917, a disastrous fire occurred at the plant of the above concern, destroying all but four frames; the keel, stem, and sternpost were uninjured.

New material was immediately procured and reconstruction commenced. The vessel was launched on June 5, 1918, and completed and delivered on July 23, 1918, ready for the installation of the propelling machinery and auxiliaries by the Government; which latter work was completed and the vessel placed in commission July 18, 1919.

*Tender "Pine."*—Due to the increase in traffic and the additional aids established along the inlets of the New Jersey coast, the need of a small, light-draft tender became apparent, and it was proposed to purchase a suitable vessel, but none was found that could be adapted to the work. Plans and specifications were accordingly prepared and bids invited for a light-draft power boat, and on June 27, 1918, a contract was awarded to the Nyack Shipbuilding Co., Nyack, N. Y., for the construction of a power boat in the sum of $9,500, payable from general expenses Lighthouse Service, 1918. The boat was completed, delivered, and placed in commission on December 9, 1918. Later a new type derrick and boom operated by a gasoline hoisting engine were installed.

*Tender "Oak."*—The act of June 12, 1917, appropriated $150,000 for a lighthouse tender for the third district to replace the tender *Gardenia* or for general service.

Specifications were prepared and bids invited for the construction of the vessel. The lowest bid received being greatly in excess of the appropriations, all were rejected. Bids were again invited on August 1, 1919, after extensive advertisement. The lowest bid received was again greatly in excess of the appropriation, and all bids are held in abeyance pending further appropriation of funds. Amount expended to June 30, 1919, $9,077.77.

*Light vessel "No. 99."*—The act of August 24, 1912, appropriated $130,000 for a light vessel for general service. Plans and specifications were prepared for a light vessel for the Great Lakes. Bids were received on May 25, 1916, and, on June 29, 1916, a contract was awarded to Rice Bros., East Boothbay, Me., in the sum of $61,000. The construction of the vessel had reached a degree of completion of approximately 54 per cent, when, on July 10, 1917, a disastrous fire occurred at the builders' plant in which the vessel and the greater part of its fittings were rendered a total loss.

The contractors took prompt steps to procure new material, and the construction of a new vessel, a duplicate of the one destroyed, was commenced. On June 30, 1919, the work had reached a degree of completion of approximately 68 per cent. Amount expended to June 30, 1919, $68,972.73.

*Light vessel "No. 100."*—Plans and specifications are in preparation for a large light vessel for station at Nantucket Shoals, Mass. There is a balance of approximately $51,600 remaining under the appropriation of August 26, 1912, for light vessels, but the construction of this vessel from the available balance will not be possible until additional funds are available to meet the higher costs of production caused by the present abnormal conditions. Estimates have been prepared and submitted, and it is now proposed to construct this vessel from the plans and specifications prepared for light vessel *No. 105.*

*Light vessels "No. 103" and "No. 104."*—The act of June 12, 1917, appropriated $150,000 for light vessels for general lake service. Plans and specifications for two vessels similar in construction to light vessel *No. 99* have been completed. Bids were received for the construction of one or both vessels, on January 15, 1918, and on June 5, 1918, a contract was awarded to the Gas Engine & Power Co. and the Charles L. Seabury Co., Morris Heights, N. Y., in the sum of $147,428 for the construction of one vessel, *No. 103*. It is proposed to invite new bids for light vessel *No. 104* when funds are available, estimates for which have been prepared and submitted. The construction of light vessel *No. 103* had reached a degree of completion of approximately 30 per cent on June 30, 1919. Amount expended up to June 30, 1919, $112.22.

*Light vessel "No. 105" (Cape Charles).*—The act of June 12, 1917, appropriated $130,000 for a light vessel for Cape Charles, Va., or for general service. Plans and specifications were prepared and bids invited for the construction of the vessel. The lowest bid received was greatly in excess of the appropriation and all bids are held in abeyance pending further appropriations, estimates for which have been submitted. No expenditures were made to June 30, 1919.

*Radio equipment for lighthouse vessels.*—The act of June 12, 1917, appropriated $60,000 for installing radio equipment on lighthouse tenders, seven tenders having been previously so equipped. This amount has not been expended, the Navy Department having used naval appropriations for the equipment of 16 tenders with radio during the war, 12 of these having been equipped during the fiscal year 1919. In all, 23 tenders were equipped with radio at the end of the fiscal year 1919. The appropriation of June 12, 1917, will be used to equip other tenders with radio apparatus as soon as practicable.

At the end of the fiscal year 41 light vessels had been equipped with radio apparatus, 32 light vessels having been so equipped during the war and 28 of these during the past fiscal year. Nine light vessels had been previously equipped with radio. The installation of radio on other light vessels is in progress. This work has been done by the Navy Department in cooperation with the Lighthouse Service and was paid for with funds from naval appropriations.

## SPECIAL WORKS OF CONSTRUCTION COMPLETED (OMITTING VESSELS).

### FIRST DISTRICT.

*Dog Island, Eastport, Me.*—The act of July 1, 1916, appropriated $3,500 for establishing an unattended light on Dog Island, Eastport, Me. Considerable delay in establishing this light was caused by having to obtain title to the site by condemnation proceedings. The tower was erected during October and November, 1918, and the light shown for the first time on January 23, 1919. The tower is a steel, skeleton structure having a concrete foundation and steel tank house. Amount expended to June 30, 1919, $3,130.35.

### EIGHTH DISTRICT.

*Aids to navigation, Caribbean Sea.*—An allotment of $100,000 was made by the President from the appropriation for national security and defense for the purpose of establishing lighted aids in the western part of the Caribbean Sea to mark the traffic lane between the western end of Cuba and the Panama Canal through the Yucatan Passage. A working party of Lighthouse Service employees was assembled, together with materials, in the eighth district. On June 3, 1919, the party sailed from New Orleans, La., on the U. S. S. *Wheeling* for the Caribbean Sea, and the work was done under the direction of the superintendent on general duty. Flashing white lights were established on three 40-foot skeleton steel towers which were erected upon concrete blocks in the following locations: Quita Sueno Bank, Roncador Cay, and Serrana Bank. The expenditures and obligations to June 30, 1919, were $26,163.87.

### TENTH DISTRICT.

*Lorain Harbor, Ohio.*—The act of October 22, 1913, appropriated $35,000 for a light and fog-signal station and improvement to aids to navigation at Lorain Harbor, Ohio. A reinforced-concrete structure for the light and fog signal has been completed. The permanent light was placed in commission April 7, 1919, and the fog signal May 13, 1919. Amount expended to June 30, 1919, $34,974.54.

### ELEVENTH DISTRICT.

*Sand Hills Light Station, Mich.*—The act of June 12, 1917, appropriated $70,000 for the construction of a light and fog-signal station at Sand Hills, Mich. A site was purchased about 3¾ miles west of Eagle River, Mich., on what is known as Five Mile Point and construction work actively commenced in the late fall of 1917. The fog signal was placed in commission on May 15 and the light on June 18, 1919. The tower is of brick and structural steel, forming the central feature of the main structure, which forms the quarters for the three keepers. Amount expended to June 30, 1919, $68,714.69.

### SEVENTEENTH DISTRICT.

*Lime Kiln Light Station, Wash.*—The act of July 6, 1916 (Kellett Bluff Light Station, Wash.), appropriated $40,000 for the construction of a light and fog-signal station at or near Kellett Bluff, Henry Island, Wash. A site known as Lime Kiln, on the west coast of San Juan Island, was selected and construction begun in August, 1918. The station was placed in commission June 30, 1919. It consists of a combined light and fog-signal building, with light tower 30 feet high and two keepers' dwellings, all of reinforced concrete. Amount expended to June 30, 1919, $38,333.80.

*Aids to navigation, Puget Sound, Wash.*—The act of October 22, 1913, appropriated $30,000 for aids to navigation and improvements to existing aids in Puget Sound, Wash., and adjacent waters. From this appropriation a new light and fog-signal building has been constructed at Marrowstone Point, Wash., the light changed from acetylene to electricity, and the fog signal from an acetylene gun to an air-operated reed horn. A flashing acetylene light has also been established at Apple Cove Point, Wash. The balance of the appropriation has been expended for a structure for Shilshole Bay Outer Light. Amount expended to June 30, 1919, $30,000.

## SPECIAL WORKS OF CONSTRUCTION UNCOMPLETED (OMITTING VESSELS).

### SECOND DISTRICT.

*Nantucket Harbor Fog Signal, Mass.*—By act of July 1, 1918, the appropriation of $15,000 contained in act of March 28, 1918, for a fog-signal whistle was made available for establishing an electrically operated fog bell on the east breakwater at Nantucket Harbor, Mass. The fog-bell tower has been completed and the bell and striker installed. The submarine cable has been purchased and laid and the generating apparatus in duplicate has been purchased and installed in the old tower at Brant Point. Amount expended to June 30, 1919, $6,582.53.

*Woods Hole (Mass.) Lighthouse Depot.*—The act of July 1, 1916, appropriated $50,000 for improvements at Woods Hole Depot, Mass. About 32,000 feet of channel, 150 feet wide, was dredged to a depth of 17 feet, and a basin in front of depot 400 by 550 feet was dredged to 17 feet at a cost of $30,162.97. A two-story storehouse, 35 by 80 feet, of brick, with steel frame and reinforced-concrete floors and roof, was finished by contract August 18, 1917. The electric lighting has been installed and an electric welding outfit purchased and installed. Amount expended to June 30, 1919, $49,028.72.

*Depot for second lighthouse district.*—The act of July 1, 1918, appropriated $85,000 for building a depot at Chelsea, Mass. Proposals for dredging and building two slips and for rebuilding the wharf were invited and opened on April 30, 1919, but were rejected owing to excessive prices. New proposals for dredging in front of wharf and east slip and for rebuilding wharf and retaining walls have been issued to be opened August 1, 1919. No expenditures were made to June 30, 1919.

*Repairing and rebuilding aids to navigation, Atlantic coast.*—From the appropriation by the deficiency act approved November 4, 1918, $11,000 was allotted for repairing damage done by ice during the winter 1917–1918 at Duxbury Pier Light Station and Scituate Breakwater Light. Six hundred tons of riprap, ranging in size from 1 to 5 ton stones, were deposited at Duxbury Pier Light Station in a mound on the northwesterly side of the tower and about 25 feet from it to protect the tower from heavy field ice and to give a more sheltered landing for the keepers. As soon as the riprap has thoroughly settled it will be securely fastened together with 1¼-inch iron dogs. Five hundred tons of granite riprap were deposited at Scituate Breakwater Light around the spindle to make a secure mound for supporting an acetylene tank house. These stones will be securely dogged during the present season, and the acetylene apparatus purchased for the site will be properly installed. Amount expended to June 30, 1919, $11,000.

### THIRD DISTRICT.

*Aids to navigation, Hudson River, N. Y.*—The act of July 1, 1916, appropriated $100,000 for improving aids to navigation and the establishment of new aids on the Hudson River, N. Y. The work of improving, rebuilding, and establishment of the aids will affect 21 different points. The work in progress consists of building and equipping a barge for the purpose, taking necessary steps toward the acquisition of required sites and the purchase of the illuminating apparatus. Work on the barge was delayed on account of destruction by fire of the contractors' shipyard. The barge was finally completed in 1918. The work accomplished up to the present consists of obtaining sites, purchasing lighting equipment, building towers, and completing the barge. Work of installing the towers and foundations will be started at once. The project was started in December, 1916, and it is expected will be completed about November 1, 1919. The amount expended to June 30, 1919, was $81,665.18.

*Hunts Point, N. Y.*—The act of March 4, 1911, appropriated $5,000 for the establishment of a light and fog signal to mark Hunts Point, between Hell Gate and Whitestone Point, East River, N. Y. The work of erecting a structure for the light and fog signal was started in November, 1916, and the light went into commission on January 4, 1917. The structure consists of a steel tower built on a stone-and-concrete foundation, with the necessary provision made for the establishment of a fog signal later, when it is practicable to procure electric current for its operation. The date of the completion of this project is indefinite, but it is expected that it will be possible to get current and have the fog signal in operation by June 1, 1920. Amount expended to June 30, 1919, $3,520.21.

*Staten Island Lighthouse Depot, N. Y.*—The act of June 12, 1917, appropriated $21,000 for improving the office and laboratory at the general lighthouse depot. The work was started in November, 1918, and has all been completed with the exception of certain minor details and the work of installing a heating system and wash rooms. It is expected the entire building will be completed by November 15, 1919. Amount expended to June 30, 1919, $7,857.16.

*Aids to navigation, East River, N. Y.*—The act of June 12, 1917, appropriated $16,000 for improving the aids to navigation in the East River, N. Y. The work to be done consists of improvements and changes in the present system of lights and the establishment of an additional light. The lighting apparatus has been purchaesd. The necessary grants for the parcels of land under water have been obtained, and bids for riprap foundations will be invited in the near future. The work was started in September, 1917, and it is expected will be completed about May 1, 1920. Amount expended to June 30, 1919, $7,947.97.

*Great Salt Pond Light Station, R. I.*—The act of June 12, 1917, appropriated $20,000 for building a new dwelling and moving the fog signal from the inner to the outer end of the breakwater. Plans for dwelling are completed. Cession of land and jurisdiction over same has been received from the State of Rhode Island. Contract has been entered into for furnishing and placing the necessary riprap for the foundation of the light, and about one-fourth of the quantity of stone contracted for has been delivered and placed on the site. Owing to increase in the cost of labor and material and to change in location of light to the extreme end of the breakwater to make the harbor convenient as a base for naval vessels, an additional appropriation is required to complete this work. The estimated additional amount required is $53,000. Work was started in May, 1919, and it is expected it will be completed about June 1, 1920, if funds are available. Amount expended to June 30, 1919, $16.62.

*Staten Island Lighthouse Depot, N. Y.*—The act of March 28, 1918, appropriated $60,000 for repairing the wharves at the general lighthouse depot, Tompkinsville, N. Y. It is proposed to remove the old wooden decks, furnish and install additional steel work, cast-iron pile columns, manhole frames, covers, and pipe hangers, and place new concrete decks on the wharves. A contract was entered into for the work to be done to the south wharf. The work was started in September, 1918, and completed in February, 1919. On account of incessant use of wharves it will be necessary to do this work in three sections, one at a time. Contract has been entered into for the second section, and it is expected the work will start in July, 1919, and be completed in September, 1919. Amount expended to June 30, 1919, $33,789.82.

*Ambrose Channel Lighted Buoys, N. Y.*—The act of July 1, 1918, appropriated $26,000 for improving the system of lighted buoys in Ambrose Channel, N. Y. The plan of general change has been approved and buoys for making the change were ordered June 17, 1919, and it is expected to have the work completed about March 1, 1920. No expenditures have yet been made from this appropriation.

*Plate shop, coal shed, etc., General Lighthouse Depot, N. Y.*—In August, 1918, an allotment of $175,000 was made from funds for national security and defense to carry out certain necessary alterations and provide certain necessary equipment at the general lighthouse depot, Tompkinsville, N. Y. These consisted of the removal of the old coal shed, the erection of a new coal shed, and the erection of two temporary coal bins for use while the new coal shed was being built, and to erect on the site of the old coal shed an extension to the present blacksmith's shop to be used as a boiler and plate shop. Temporary coal bins were erected, the old coal shed was torn down, and a new iron rack built to replace one removed to make room for plate shop. Contract has been entered into for the erection of the new coal pocket and for furnishing new plate-working machinery. It is expected the work on new coal pocket will be started about July 3, 1919, and will be finished about December 30, 1919. It is expected the entire project will be completed about February 1, 1920. Amount expended to June 30, 1919, $16,635.85.

### FOURTH DISTRICT.

*Joe Flogger Shoal, Del.*—The act approved July 1, 1918, provided that the unexpended balance of the appropriation of $40,000 "toward a light and fog-signal station of the Joe Flogger Shoal, Delaware River," contained in the act approved June 13, 1906, be made available for establishing gas buoys and improving aids to navigation in the vicinity of Joe Flogger Shoal, Del. Under this appropriation five modern gas buoys are now being manufactured, and orders for additional buoys, etc., will be placed in the near future. It is expected that all work under this appropriation can be completed during 1920. Amount expended to June 30, 1919, $609.25.

*Delaware River, Pa. and Del., aids to navigation.*—The act of March 3, 1915, authorized this work. The act of July 1, 1916, appropriated $80,000 for the purpose. Under the appropriation the following work was performed or was underway at the close of the fiscal year:

Chester Range Front: This station was completed. It consists of a foundation crib in 13 feet at mean low water supporting a 50-foot structural-steel tower, from which is shown a flashing automatic acetylene light. Station is protected by riprap.

Chester Range Rear: This station was completed. It consists of a 100-foot structural-steel tower on concrete piers supported by timber grillage. The light is fixed-white, automatic, acetylene.

Marcus Hook Range Front: This station was completed. It consists of a concrete block on a pile foundation at low-water mark, supporting a 72-foot structural-steel tower, from which is shown a flashing, automatic, acetylene light.

Marcus Hook Range Rear: This station when completed will consist of a 100-foot detached, concrete tower and a brick dwelling. The light will be incandescent oil vapor and be shown from a range lens. It is 95 per cent completed. A temporary acetylene light is shown from the balcony of the new tower. Approximate date of completion is October 1, 1919. Under the appropriation the bell at Fort Mifflin fog signal was replaced by an electric siren. All work under this appropriation should be completed during 1920. Amount expended to June 30, 1919, $57,429.48.

### FIFTH DISTRICT.

*Aids to navigation, Cape Charles City, Va.*—The act of June 12, 1917, appropriated $12,800 for improving lights and fog signals leading to Cape Charles City, Va. Plans and specifications have been prepared for the ironwork and the erection of Cherrystone Bar Light to cover a small, caisson-type structure which will show an unwatched acetylene light and support an automatic fog bell actuated by carbon-dioxide gas. The ironwork is on hand, and the contract has been let for the erection of the structure. Amount expended to June 30, 1919, $3,524.

*Aids to navigation, Chesapeake Bay, Md. and Va.*—The act of June 12, 1917, appropriated $29,000 for aids to navigation of the Eastern Shore of the Chesapeake Bay and tributaries. Requisition has been made for four type S buoys for the Susquehanna River and the Eastern Shore, Md., of which one has been delivered. Amount expended to June 30, 1919, $5,865.47.

*Repairing and rebuilding aids to navigation, Atlantic Coast.*—The act of March 28, 1918, appropriated $150,000 for rebuilding, repairing, and reestablishing aids damaged by storm and ice, from which $100,000 was allotted to the fifth district. The act of November 16, 1918, appropriated $284,000 additional for the fifth district for the same purpose. Riprap has been placed at the following light stations to protect them from further damage: Cedar Point, Point Lookout, Ragged Point, Blakistone Island, and Mathias Point Shoal, all in Maryland. Ironwork has been repaired at Love Point Shoal Light Station, Md., and Killick Shoal Light Station, Va. Contract has been let for repairs to ironwork at Thomas Point Shoal Light Station, Md. Contract has been let for concrete foundation, and work is in progress at Tangier Sound Light Station, Va. Bids were rejected as excessive for new foundation for Brant Island Shoal and Wade Point Light Station, N. C. New plans for the work are in preparation. Contract has been awarded for protecting with riprap stone the following light stations: Thomas Point Shoal, Cedar Point, Point Lookout, Cobb Point Bar, and Maryland Point, all in Maryland; and Windmill Point, Va. Plans and specifications have been prepared for a steel sheet piling and concrete foundation for Old Plantation Flats Light Station, Va. One hundred and eighty minor lights and daymarks, which were damaged or carried away by ice, have been repaired, rebuilt, or reestablished. Amount expended to June 30, 1919, $102,944.95.

*Additional gas buoys.*—Appropriations amounting to $125,000 were made by acts of Congress approved July 1, 1918, and November 4, 1918, for additional gas buoys for the improvement of aids to navigation in the fifth district. Requisition has been made on the general depot for the following: Five gas and whistling buoys, 8 gas and bell buoys, 13 gas buoys, 19 buoy lanterns, and other material.

In addition, one gas and whistling buoy has been purchased for Cape Lookout Harbor of Refuge. The amount expended to June 30, 1919, was $120,209.21.

### SIXTH DISTRICT.

*St. Johns River, Fla.*—The act of July 1, 1916, appropriated $66,000 for improving aids to navigation and establishing new aids on the St. Johns River, Fla.

From this appropriation the following works have been accomplished: Six lights, 3 unlighted beacons, and 2 gas buoys have been established; 14 light structures have been rebuilt; buoyage improved and repairs effected at various stations; and illuminating apparatus purchased for converting 3 range lights from oil to acetylene. The amount expended to June 30, 1919, was $35,098.03.

### SEVENTH DISTRICT.

*Florida Reefs, Fla.*—The act of July 1, 1916, appropriated $75,000 for establishing additional aids and repairing and improving existing aids. Under this appropriation part of the illuminating apparatus has been purchased. Three attempts have been made to obtain proposals for metal work and glass without success; advertisement for proposals for these materials have again been issued, to be opened on August 30, 1919. The date of completion is indefinite. Amount expended to June 30, 1919, $3,427.56.

### EIGHTH DISTRICT.

*Aids to navigation, Atchafalaya Entrance Channel, La.*—The act of October 22, 1913, appropriated $50,000 for establishing aids to navigation in Atchafalaya Entrance Channel, La. During the fiscal year ended June 30, 1916, Point Au Fer Reef Lighthouse and Atchafalaya Entrance Channel Lights Nos. 1, 3, 5, 7, 9, and 2 were completed. A 42-foot motor launch was completed by the United States Naval Station, New Orleans, La., during the fiscal year 1918 at a cost of $6,951.71. Amount expended to June 30, 1919, $40,995.06.

*Aids to navigation, Mississippi River, La.*—The act of July 1, 1916, appropriated $50,000 for the improvement of aids to navigation of the Mississippi River below New Orleans. Contract was entered into June 22, 1917, for furnishing 25 structural-steel towers. The towers were delivered to the Mobile depot during the year. Amount expended to June 30, 1919, $18,658.07.

*Aransas Pass Light Station, Tex.*—The act of October 6, 1917, appropriated $20,000 for repairing and rebuilding dwellings, outbuildings, and appurtenant structures damaged or destroyed in the hurricane of August 18, 1916. During the fiscal year 1918 the contract was awarded for building a dwelling, oil house, T wharf, walks, etc. The contractor commenced work at the station during May, 1918, and at the end of the fiscal year 1919 had completed the outhouses, oil house, walks, and wharf, and had progressed to the plastering of the dwelling and was engaged in work on the roof, pavement under dwelling, painting, etc. Amount expended to June 30, 1919, $10,450.95.

*Galveston Jetty Light Station, Tex.*—The act of June 11, 1896, appropriated $35,000, and the act of May 27, 1908, $10,000 for establishing a light and fog-signal station at or near the outer end of one of the jetties at Galveston Harbor, Tex. Great damage was done the uncompleted structure by the hurricane of August 16–17, 1915, which destroyed the construction wharf, bent the framework of the structure, and washed away much material. Subsequently materials were again assembled, another wharf erected, and the framework straightened. The construction work was again washed away in the hurricane of August 18, 1916, and some of the lower struts of the substructure were again bent. A portion of the lens for this station was lost in the hurricane of July 5–6, 1916, one box containing parts of same having been washed away from the Mobile Lighthouse Depot. It was replaced from the third district. In March, 1917, the installation of intermediate beams to reinforce struts was completed. A concrete block 40 feet square around foundation piles, and in places 10 to 15 feet in depth, on northerly and southerly edges, was completed during the fiscal year

1918, and the illuminating apparatus was installed. A fog bell struck by machinery will be installed during the next fiscal year. The light was exhibited November 12, 1918. Amount expended to June 30, 1919, $44,901.13.

*Repairing and rebuilding aids to Navigation, Gulf of Mexico.*—The act of February 28, 1916, appropriated $200,000 for repairing and rebuilding aids to navigation damaged or destroyed by hurricane on the Gulf of Mexico. In addition to the work which had been completed, as stated in the annual reports for the fiscal years ended June 30, 1917, and June 30, 1918, there is given below a list of the work that has been completed during present fiscal year and that in progress. During the fiscal year the following portions of the work have been completed:

Bayou St. John Light Station, La.: Wharf, fence, roof, and gutters repaired.

Cape San Blas Light Station, Fla.: Tower moved to new location.

Cat Island Light Station, Miss.: New wharf on creosoted piles, with creosoted stringers, headers, and braces; new boathouse on square, sawn, creosoted piles, with cast-iron pipe sleeves: new platform under station, etc.

Chandeleur Light Station, La.: Rebuilt wharf and walk, and platform under house, and minor repairs made.

Pass Manchac Light Station, La.: Rebuilt 130 feet cypress sheet-pile breakwater; storehouse and boathouse on creosoted piles; also rebuilt fence, etc.

Sabine Bank Light Station, Tex.: Iron shell plates, davits, footplates, railing, etc., were installed, closing in the veranda.

St. Andrews Bay Range Front Light, Fla.: Temporary, single, iron-cased pile structure rebuilt, showing a post-lantern light.

The following work is in progress at the end of the fiscal year:

Calcasieu Range Rear Light Station, La.: Rebuilding walk, boathouse, and repairing station.

Galveston Depot, Tex.: Creosoted piles and untreated lumber, etc., purchased.

Amount expended to June 30, 1919, $179,784.74.

The act of September 8, 1916, appropriated $125,000 for repairing and rebuilding aids to navigation damaged or destroyed by hurricane on the Gulf of Mexico, of which $122,200 was alotted for this district. In addition to the work which had been completed, as stated in the annual reports for the fiscal years ended June 30, 1917, and June 30, 1918, there is given below a list of the work that has been completed during present fiscal year and that in progress. During the fiscal year the following portions of the work have been completed:

Cape San Blas Light Station, Fla.: Tower moved to new location.

Chandeleur Light Station, La.: Wharf, walk, platform, and stairways rebuilt.

Pascagoula River Entrance Light Station, Miss.: Rebuilt 180 feet of walk, fence, and repaired water-closet, gallery, steps, etc.

Ship Island Light Station, Miss.: Wharf, walk, and bulkhead rebuilt.

Amount expended to June 30, 1919, $109,712.01.

The act of March 28, 1918, appropriated $100,000 for rebuilding, repairing, and reestablishing aids to navigation and structures connected therewith on the coast of the Gulf of Mexico damaged or destroyed by hurricane. There is given below a list of work which has been completed during the present fiscal year and of that in progress. During the fiscal year the following portions of the work have been completed:

Bayou Chamier Range Rear Light, Miss.: Rebuilt single iron-cased pile structure showing a post-lantern light.

Blackwater Bay Channel Range Lights, Fla.: Both structures repaired.

Cape San Blas Light Station, Fla.: Rebuilt brick oil house in new location.

Deer Point Light, Fla.: Four iron-cased pile structures rebuilt, showing a lens-lantern light.

East Bay Channel Range Lights, Fla.: Both structures repaired.

Fair Point Light, Fla.: Four iron-cased pile structures rebuilt, showing a lens-lantern light.

Middle Beacon, Fla.: Rebuilt as a single iron-cased pile structure with topmast and day mark.

White Point Light, Fla.: Four iron-cased pile structures rebuilt, showing a lens-lantern light.

The following work is in progress at the end of the fiscal year:

Circle Crossing Range Lights, Fla.: Rebuilding one single iron-cased pile structure and repairing the other.

Hurricane Crossing Range Rear Light, Fla.: Rebuilding single-pile structure.

Santa Rosa Sound Range Lights, Fla.: Rebuilding both structures on four iron-cased piles, showing lens-lantern lights.

Amount expended to June 30, 1919, $44,595.60.

*Sabine Pass Jetty Light, La.*—The act of May 27, 1908, appropriated $40,000 for a light and fog signal at or near the end of Sabine Pass Jetty. Nothing has been done on the work in view of the proposed project of the War Department to extend the jetties to the 25-foot contour, a distance of possibly 2 miles. At the close of the fiscal year 1919 no money had been expended or obligated.

*Sand Island Light Station, Ala.*—The act of July 1, 1919, appropriated $37,000, for improvements. At the close of the fiscal year, no money had been expended or obligated.

### NINTH DISTRICT.

*Point Borinquen Light Station, P. R.*—The act of June 12, 1917, appropriated $85,000 for constructing Point Borinquen Light Station. The third-order lantern and metal work for the station are being made by contract, and the work is nearing completion. Plans and specifications for construction of tower and dwelling are prepared, and bids will be invited by the Bureau as soon as the metal work is completed. Work on illuminating apparatus is in progress at the general depot. Amount expended to June 30, 1919, $11,394.13.

*Aids to navigation, Guantanamo Bay, Cuba.*—The act of July 1, 1918, appropriated $14,000 for dwellings for keepers of lights in Guantanamo Bay, Cuba, and improving the lighting. Contracts have been let for furnishing materials for dwelling, which will be built by hired labor. Skeleton steel towers for Hicacal Beach and Fishermans Point Ranges, and submarine-cable electric equipment for these lights have been ordered. Amount expended to June 30, 1919, $3,680.

*Dwelling, Port San Juan Light Station.*—The act of July 19, 1919, appropriated $50,000 for light keepers' dwellings. The Bureau has requested preliminary plans and report for a double dwelling for Port San Juan Light Station.

### TENTH DISTRICT.

*Conneaut Harbor, Ohio.*—The act of July 1, 1916, appropriated $63,500 for a light and fog-signal station and improving aids to navigation at Conneaut Harbor, Ohio. Concrete foundation completed. Metal work, brick, stone, and other materials for superstructure delivered at site. Contract awarded for lantern. Work at site on superstructure resumed in June, 1919. Additional appropriation of $19,600 required to complete project. Probable date of completion August 1, 1920. Amount expended to June 30, 1919, $42,478.22.

*Huron Harbor, Ohio.*—The act of June 12, 1917, appropriated $4,500 for establishing aids to navigation at Huron Harbor, Ohio. Steel tower erected on concrete foundation ready for installation of electric light. Work in progress. Light will probably go in commission about July 15, 1919. Amount expended to June 30, 1919, $3,450.34.

*Fairport Harbor, Ohio.*—The act of June 12, 1917, appropriated $42,000 for improving aids to navigation at Fairport Harbor, Ohio. Plans for this project are being prepared. Owing to war conditions and increased prices, the amount appropriated is insufficient, and an additional appropriation of $35,500 has been recommended. Amount expended to June 30, 1919, $1,395.

### ELEVENTH DISTRICT.

*Detroit River, Mich.*—The act of March 4, 1911, appropriated $210,000 for establishing aids to navigation along the Livingstone Channel, Detroit River, Mich. Twelve concrete piers have been constructed, nine of which have been provided with lights, the lighting of the other three having been deferred pending contemplated changes in the channel by the United States engineers. Two more lighted piers will be established when these changes have been completed. A semaphore system has also been installed for controlling the movements of vessels through the channel. In addition to these fixed aids, 13 gas buoys and 21 spar buoys are in commission. Plans have also been prepared for a light and fog signal at the southern end of the channel, but, as the site is in Canadian waters, no further steps have been taken toward the construction of this station by the United States. Negotiations are, however, under way with the Canadian Government for the establishment by them of a suitable aid at this place. Amount expended to June 30, 1919, $150,991.19.

*Aids to navigation, Fighting Island Channel, Detroit River, Mich.*—The act of July 1, 1916, appropriated $25,000 for aids to navigation, Fighting Island Channel, Detroit River, Mich. Two nonattended acetylene lights and four acetylene gas buoys have been established, and single lights maintained in place of four ranges which are no longer required owing to straightening of channel. Lighting equipment has been purchased for converting three of these single lights to nonattended acetylene. Amount expended to June 30, 1919, $18,005.32.

*Aids to navigation, Keweenaw Waterway, Mich.*—The act of June 12, 1917, appropriated $100,000 for aids to navigation, Keweenaw Waterway, Mich. The features included in this project are as follows: New dwelling for keeper and enlarging present single dwelling to a double dwelling, power house, boathouse, oil house, light and fog-signal station and establishment of 20 minor lights with electric illuminant along the Portage River. Practically all material has been delivered, and the work of construction is well advanced. It is expected that the principal structures will be completed this season, and the entire project, with the exception of a few minor lights, finished during the present fiscal year. Amount expended to June 30, 1919, $72,909.

*Aids to navigation, St. Marys River, Mich.*—The act of November 7, 1918, appropriated $80,000 for improving aids to navigation in St. Marys River, Mich. The work contemplated includes the establishment of two acetylene lights, repairs and improvements to existing aids, quarters for one keeper, and electric generating station and wiring equipment for lights in Middle Neebish Channel. Acetylene equipment and steel towers have been delivered and work actively begun. Amount expended to June 30, 1919, $1,391.39.

*Spectacle Reef Light Station, Mich.*—The act of July 1, 1918, appropriated $28,000 for repairing the substructure of this station, which is being seriously undermined. Preliminary examinations have been made and will be extended during the current season and arrangements completed for carrying out the work next year. No expenditures have been made from this appropriation.

*Detroit Lighthouse Depot, Mich.*—The act of July 1, 1918, appropriated $53,000 for improvements at the Detroit Lighthouse Depot, Mich. Materials are being purchased and proposals invited for constructing a new concrete wharf to replace the present timber structure. Upon completion of the wharf, the depot lamp shop will be extended and additional machinery installed. Amount expended to June 30, 1919, $14,896.14.

### TWELFTH DISTRICT.

*White Shoal, Mich.*—The act of March 4, 1907, appropriated $250,000 for a light and fog-signal station at White Shoal, Mich., in the north end of Lake Michigan, to replace the White Shoal Light Vessel. The tower was completed and the light placed in commission September 1, 1910, and the fog signal on September 15, 1910. A submarine bell was established September 20, 1911, and later discontinued. A water-supply system was installed in October, 1911, and an oil-supply system in June, 1913. Riprap was placed about the station in August, 1914, and an auxiliary acetylene light for winter service was established in December of the same year. An allotment of $1,900 has been made from the special appropriation for air hoists for the three boat cranes. Equipment for same has been purchased and will be installed this year. Amount expended to June 30, 1919, $226,507.12.

*Chicago Harbor, Ill.*—The act of June 12, 1917, appropriated $88,000 for the removal and rebuilding of Chicago Harbor Light Station on a new site at the south end of the north arm of the extension of the exterior breakwater, north side of Chicago Harbor; also for the establishment of two minor lights on the north and south ends of the south arm extension. This work has been completed except some interior finish and lining and installation of plumbing and heating plant in main structure, a concrete landing dock at the South Side Light and the erection of the South End Light, materials for which are on hand. This latter awaits completion of breakwater extension by the United States engineers. Work on these projects was discontinued in January, 1919, owing to exhaustion of funds. An additional appropriation will be required to complete this work. Amount expended to June 30, 1919, $87,584.63.

*Manitowoc Breakwater, Wis.*—The act of June 12, 1917, appropriated $21,000 for improving the light and fog-signal station at Manitowoc, Wis. The old frame structure has been removed from the site at the outer end of the north breakwater, new concrete substructure provided, and steel light and fog-signal station erected thereon. A light was installed in the new building on November 15, 1918. A steel switch house at shore end of breakwater has been erected, and 2,400 feet of conduit connecting it with the station is in place. Work remaining to be done consists in placing lining and interior finish, purchase of air-compressing plant, and installation of fog-signal apparatus and electric cable. Work was suspended owing to exhaustion of funds. An additionl appropriation will be required to complete this project. Amount expended to June 30, 1919, $20,823.53.

*Indiana Harbor, Ind.*—The act of June 12, 1917, appropriated $100,000 for the establishment and improvement of aids to navigation at Indiana Harbor, Ind. A timber crib foundation with concrete capping will be placed this season by the United States engineers, upon which will be erected the light and fog-signal station. Two steel towers for minor lights on west breakwater and south pier are being purchased. Amount expended to June 30, 1919, $28.

### SIXTEENTH DISTRICT.

*Ketchikan Lighthouse Depot, Alaska.*—The act of July 1, 1918, appropriated $90,000 for a lighthouse depot and the necessary equipment for the Sixteenth lighthouse district. The site has been cleared over the area to be occupied by warehouse, shops, etc. The wharf was 95 per cent completed on June 30, 1919. Cement, reinforcing steel, steel sash, and nearly all the other materials required in the erection of a two-story, reinforced-concrete warehouse have been purchased and are on the ground. The work is being done by day labor under a competent foreman. On June 30, 1919, the work had reached a degree of completion of approximately 35 per cent of the total improvements originally contemplated. Amount expended to June 30, 1919, $48,589.95, or approximately 55 per cent of the total appropriation.

*Aids to navigation, Alaska.*—The act of June 12, 1917, appropriated $60,000 for establishing and improving aids to navigation in Alaskan waters. During the fiscal year 1919 one gas and bell buoy and 8 acetylene lights were established from above appropriation. Amount expended to June 30, 1919, $52,087.15.

### SEVENTEENTH DISTRICT.

*Aids to navigation, Coquille River, Oreg.*—The act of July 1, 1916, appropriated $6,000 for this project, which contemplated the removal of the light and fog signal to the south side of the entrance. Navigators and others having petitioned that no change be made in the establishment, no work has been done nor have any funds been expended during the year. Navigation interests desire that certain additional aids be provided at the entrance and a project is in course of preparation. Amount expended to June 30, 1919, $36.34.

*Aids to navigation, Wash. and Oreg.*—The act of June 12, 1917, appropriated $35,000 for new aids and improvements to existing aids. Under this appropriation four acetylene post lights and two oil-burning post lanterns have been established, two acetylene buoys have been constructed, one acetylene post light structure reconstructed, two new structures and outfits prepared ready for installation, and materials purchased for an electric installation at a light station now using incandescent oil vapor, and two new electric lights have been established. Amount expended to June 30, 1919, $16,362.95.

### EIGHTEENTH DISTRICT.

*Point Vincente, Calif.*—The act of July 1, 1916, appropriated $80,000 for establishing a light and fog signal at Point Vincente, Calif. The site is under controversy, and the United States attorney prepared the data preliminary to entering suit for condemnation of suitable site; action has been deferred, and the condemnation suit has been postponed pending further negotiations with present owners. The date of completion will depend upon the acquisition of the site. Amount expended to June 30, 1919, $13.50.

### NINETEENTH DISTRICT.

*Aids to navigation, Pearl Harbor, Hawaii.*—The act of March 3, 1915, authorized $80,000 for establishing aids in Pearl Harbor, which amount was appropriated by act of June 12, 1917. Location of aids determined and borings made. Privilege to occupy sites and lay necessary cable secured. System of lights satisfactory to the Navy Department has been approved. Plans and specifications of the proposed structures approved by the Bureau. Work will be advertised and bids received at an early date with the view of completing the structures by the close of the next fiscal year. Probable date of establishment, September 1, 1920. Amount expended to June 30, 1919, $9,061.19.

## UNEXPENDED BALANCES ON JUNE 30, 1919, FROM APPROPRIATIONS FOR SPECIAL WORKS.

| District. | Title of appropriation. | Acts. | Balance. |
|---|---|---|---|
| General | Repairing and rebuilding aids to navigation, Atlantic coast. | Mar. 28, 1918: Nov. 4, 1918 | $297,817.57 |
| | Tender for first lighthouse district | May 27, 1908: Mar. 4, 1909 | 4,312.21 |
| | Light vessels for general service | Aug. 24, 1912: Aug. 26, 1912 | 128,754.95 |
| | Lighthouse tender, general service | Jan. 25, 1915 | 1,468.17 |
| | Light vessels for general lake service | June 12, 1917 | 149,887.78 |
| | Radio installations on lighthouse tenders | do | 56,935.01 |
| | Oil houses for light stations | June 25, 1910 | 474.52 |
| 1st | Dog Island Light, Me | July 1, 1916 | 388.11 |
| 2d | Cape Cod Canal Lights, Mass | Aug. 1, 1914 | 94.91 |
| | Woods Hole Lighthouse Depot, Mass | July 1, 1916 | 971.28 |
| | Nantucket Harbor Fog Signal, Mass | Mar. 28, 1918 | 9,974.47 |
| | Depot for second lighthouse district | July 1, 1918 | 85,000.00 |
| 3d | Hunts Point Light Station, N. Y | Mar. 4, 1911 | 1,479.79 |
| | Aids to navigation, Hudson River, N. Y | July 1, 1916 | 17,509.45 |
| | Tender for third lighthouse district | June 12, 1917 | 149,922.23 |
| | Aids to navigation, East River, N. Y | do | 8,070.82 |
| | Great Salt Pond Light Station, R. I | do | 19,983.38 |
| | Staten Island Lighthouse Depot, N.Y. (wharves). | Mar. 28, 1918 | 26,210.18 |
| | Staten Island Lighthouse Depot, N. Y. (carpenter's shop). | Aug. 1, 1914 | 1,144.51 |
| | Staten Island Lighthouse Depot, N. Y (office and laboratory). | June 12, 1917 | 13,142.84 |
| | Ambrose Channel Lighted Buoys, N. J | July 1, 1918 | 26,000.00 |
| | National security and defense, Department of Commerce, 1919 (Tompkinsville). | do | 158,364.15 |
| 4th | Joe Flogger Shoal Light Station, Delaware River. | June 30, 1906: July 1, 1918 | 31,470.75 |
| | Aids to navigation, Delaware River, Pa. and Del. | July 1, 1916 | 22,578.02 |
| 5th | Thimble Shoal Light Station, Va | June 25, 1910: Aug. 26, 1912 | 1,854.05 |
| | Lighting Norfolk Harbor, Va | Mar. 4, 1911 | 247.12 |
| | Cape Charles Light Vessel, Va | June 12, 1917 | 130,000.00 |
| | Aids to navigation, Cape Charles City, Va | do | 9,276.00 |
| | Aids to navigation, Chesapeake Bay, Md, and Va. | do | 27,798.20 |
| | Fifth lighthouse district gas buoys | July 1, 1918: Nov. 4, 1918 | 85,304.77 |
| 6th | Tender engineer, sixth lighthouse district | May 27, 1908 | 786.17 |
| | Aids to navigation, St. Johns River, Fla | July 1, 1916 | 35,159.89 |
| 7th | Aids to navigation, Florida Reef, Fla | do | 71,572.44 |
| 8th | Galveston Jetty Light Station, Tex | June 11, 1896: May 27, 1908 | 98.97 |
| | Sabine Pass Jetty Light Station, Tex | May 27, 1908 | 40,000.00 |
| | Southwest Pass Light Vessel, Mississippi River | Oct. 22, 1913 | 14,404.75 |
| | Aids to navigation, Atchafalaya Entrance Channel, La. | do | 11,189.99 |
| | Repairing and rebuilding aids to navigation, Gulf of Mexico. | Feb. 28, 1916: Sept. 8, 1916: Mar. 28, 1918. | 102,464.17 |
| | Aids to navigation, Mississippi River, La | July 1, 1916 | 31,341.93 |
| | Tender and barge, for eighth lighthouse district | do | 19,986.86 |
| | Aransas Pass Light Station, Tex | Oct. 6, 1917 | 9,549.05 |
| | National Security and Defense, Department of Commerce, 1919 (Caribbean Sea). | July 1, 1918 | 35,619.62 |
| | Sand Island Light Station, Ala | do | 37,000.00 |
| 9th | Aids to navigation, Guantanamo Bay, Cuba | do | 14,000.00 |
| | Navassa Island Light Station, West Indies | Oct. 22, 1913 | 3,948.32 |
| | Point Borinquen Light Station, P. R | June 12, 1917 | 84,498.67 |
| 10th | Aids to navigation, Ashtabula Harbor, Ohio | Oct. 22, 1913 | 2,054.97 |
| | Aids to navigation, Lorain Harbor, Ohio | do | 25.46 |
| | Aids to navigation, Conneaut Harbor, Ohio | July 1, 1916 | 21,021.78 |
| | Aids to navigation, Toledo Harbor, Ohio | do | 1,446.78 |
| | Aids to navigation, Huron Harbor, Ohio | June 12, 1917 | 978.46 |
| | Aids to navigation, Fairport Harbor, Ohio | do | 40,605.00 |
| 11th | Superior Pierhead Range Lights, Wis | June 30, 1906 | 70.10 |
| | Detroit River Lights, Mich | Mar. 4, 1911 | 59,026.32 |
| | Aids to navigation, Fighting Island Channel Detroit River, Mich. | July 1, 1916 | 7,125.40 |
| | Sand Hills Light Station, Mich | June 12, 1917 | 990.29 |
| | Aids to navigation, Keweenaw Waterway, Mich. | do | 32,250.59 |
| | Detroit Lighthouse Depot, Mich | July 1, 1918 | 38,120.93 |
| | Spectacle Reef Light Station, Mich | do | 28,000.00 |
| | Aids to navigation, St. Mary's River, Mich | Nov. 4, 1918 | 78,774.84 |
| 12th | White Shoal Light Station, Lake Michigan | Mar. 4, 1907 | 23,492.88 |
| | Chicago Harbor Light Station, Ill | June 12, 1917 | 460.81 |
| | Manitowoc Breakwater Light Station, Wis | do | 176.47 |
| | Aids to navigation, Indiana Harbor, Ind | do | 99,972.00 |
| 16th | Aids to navigation, Alaska | June 12, 1917 | 2,186.91 |
| | Cape St. Elias Light Station, Alaska | Oct. 22, 1913 | 200.16 |
| | Depot for sixteenth lighthouse district | July 1, 1918 | 41,410.05 |
| 17th | Kellett Bluff Light Station, Wash | July 1, 1916 | 1,532.86 |
| | Aids to navigation, Coquille River, Oreg | do | 5,963.66 |
| | Aids to navigation, Washington and Oregon | June 12, 1917 | 18,757.45 |
| 18th | Point Vincente Light Station, Calif | July 1, 1916 | 79,986.50 |
| 19th | Aids to navigation, Pearl Harbor, Hawaii | June 12, 1917 | 71,065.18 |

## SAVING OF LIFE AND PROPERTY BY VESSELS OR EMPLOYEES OF THE LIGHTHOUSE SERVICE DURING THE FISCAL YEAR 1919.

| District. | Vessel or employee rendering service. | Vessel, etc., aided. | Nature of assistance. |
|---|---|---|---|
| 1st | J. M. Anderson, second assistant keeper, Cape Elizabeth Light Station, Me. | | Assisted 2 Coast Guard men in rescuing man from drowning. |
| | Tender Hibiscus | Schooner L. L. Hamlin. | Floated schooner which was aground, having run ashore during thick fog. |
| | C. E. B. Stanley, keeper, Indian Island Light Station, Me. | Yacht | Assisted in towing to a safe anchorage a yacht which had broken from her moorings. |
| | E. S. Farren, keeper, Eagle Island Light Station, Me. | do | Saved boat from being badly damaged or lost by hauling it off rocks. |
| | Harry Smith, keeper; Roscoe Chandler, first assistant keeper; Harry M. Kelley, second assistant keeper; Boon Island Light Station, Me. | Schooner Hazel E. Ritcey. | Rendered assistance to crew of 7 men from schooner which struck on rock near station and sank; furnished them with food and lodging. |
| | P. L. Marr, keeper; E. V. Talbot, assistant keeper; The Cuckolds Light Station, Me. | Yacht | Towed yacht off ledge near station. |
| | Tender Hibiscus | Schooner J. R. Penrose. | Hauled schooner off rocks at mouth of Kennebec River. |
| | do | Schooner Irene E. Meservey. | Towed schooner, partially dismantled, from position about 6 miles off Seguin Light Station, to anchorage in Boothbay Harbor, Me. |
| | Tender Zizania | Steamer Mary Jane | Towed disabled steamer a distance of 3 miles to Peaks Island and landed several passengers, thence to Customhouse Wharf, Portland. |
| | W. F. Lurvey, keeper, Wood Island Light Station, Me. | Motor boat | Rendered assistance to 3 men in boat which had run onto the island. |
| 2d | C. A. Baker, keeper, Butler Flats Light Station, Mass. | Sailboat | Rescued 3 men from capsized boat and towed boat to station. |
| | Tender Azalea | Steamer North Land. | Went alongside and took off 78 passengers and baggage and landed them at New Bedford, Mass., and assisted in transferring rest of passengers to steamer Uncatena. |
| | Tender Anemone | do | Found 3 tugs trying to pull ship from ledge. Ran hawser to ship's starboard quarter and pulled vessel from ledge. |
| | A. L. Payne, keeper, Bakers Island Light Station, Mass. | Passenger launch Melba. | Towed disabled launch, which was drifting toward rocks at Beverly, to Salem Willows. |
| | do | Motor boat | Towed to Manchester, Mass., disabled launch with 7 passengers aboard, which was drifting between House and Ram Islands. |
| 3d | Geo. W. Denton, jr., keeper, Great Beds Light Station, N. J. | Rowboat | Took 2 men who were exhausted and cold to light station, and then to Perth Amboy. |
| | Tender Larkspur | Steamer Cervantes | Assisted in controlling fire aboard steamer and in keeping burning oil from spreading over harbor. |
| | Mrs. Harvey D. Munn, daughter of late keeper F. M. Best, Hudson City Light Station, N. Y. | | Launched boat from station and rescued man and boy from drowning. |
| | Five-Fathom Bank Light Vessel No. 79, N. J. | Aeroplane | Went to assistance of disabled aeroplane, and took body of aviator, who was killed, and his companion aboard light vessel power boat, and also took plane in tow until relieved by naval vessel. |
| | Arden A. Penn, assistant keeper; Kiple A. Stryker, second assistant keeper; West Bank Light Station, N. Y. | Rowboat | Rendered assistance to disabled boat, with 2 men aboard, by towing it to station landing, and furnished men food and shelter. |
| | Wm. F. Petzolt, keeper, Stratford Point Light Station, Conn. | Motor boat | Furnished lubricating oil to disabled boat. |
| | Daniel F. McCourt, first assistant keeper; Robt. Wagoner, second assistant keeper; West Bank Light Station, N. Y. | Motor boat Adelade. | Took disabled motor boat in tow and restored engine to working order. |

## SAVING OF LIFE AND PROPERTY BY VESSELS OR EMPLOYEES OF THE LIGHTHOUSE SERVICE DURING THE FISCAL YEAR 1919—Continued.

| District. | Vessel or employee rendering service. | Vessel, etc., aided. | Nature of assistance. |
|---|---|---|---|
| 3d | J. A. Davis, keeper, Saybrook Breakwater Light, Conn. | Launch | Took disabled launch and occupants to Lenwick Pier at Saybrook Point, where engine could be repaired. |
| | Otis L. Barstow, keeper, Mussel Beds Shoals Light, R. I. | Launch Kelley | Went to assistance of disabled launch, with 2 men aboard, and towed it to safety. |
| | J. A. Davis, keeper, Saybrook Breakwater Light, Conn. | | Rescued man from drowning and took him to station, where he was furnished dry clothing and food. |
| 4th | Charles R. Manlove, keeper; John Colofen, additional first assistant keeper; Brandywine Shoal Light Station, Del. | Naval Patrol Boat No. 311. | Repaired disabled engine during storm and furnished 2 exhausted sailors food and shelter. |
| | Freddie C. Hill, keeper, Baker Range Light Station, Del. | | Rescued man who had fallen in ice near station and furnished him dry clothing and food after medical assistance had been rendered. |
| 5th | Fenwick Island Shoal Light Vessel No. 52, Del. | Aeroplane | Rendered assistance to aeroplane and towed same to Lewes, Del. |
| | A. J. Simpson, keeper, Blakistone Light Station, Md. | Sailboat | Rescued sailboat, with 5 occupants, from a deep hole of whirlpools. |
| | H. C. Groome, keeper; Benjamin D. Preston, assistant keeper; Thimble Shoal Light Station, Va. | Motor boat | Rendered assistance to disabled motor boat with 6 occupants. |
| | C. A. Stirling, keeper, Craney Island Light Station, Va. | Gasoline launch | Rendered assistance to disabled launch with 2 occupants. |
| | G. M. Wible, keeper, Tangier Sound Light Station, Va. | Barge | Rendered assistance to barge grounded near the light station. |
| | S. B. Meekins, assistant keeper, North River Light Station, N. C. | Motor boats | Rendered assistance to 2 motor boats that were aground. |
| | R. H. Mathews, assistant keeper, Deep Water Shoals Light Station, Va. | Sailboat | Rescued 4 soldiers adrift in a sail boat during a storm. |
| | Charles N. Pugh, keeper, Roanoke Marshes Light Station, N. C. | Steamer Hattie Creef | Assisted captain and engineer in boarding steamer which had broken from her moorings during a storm. |
| | I. C. Meekins, keeper, Croatan Light Station, N. C. | | Rescued woman from drowning and assisted in rescuing 3 other persons. |
| | John E. Morgan, second assistant keeper, Wolf Trap Light Station, Va. | Aeroplane | Rendered assistance to aeroplane containing 3 occupants. |
| | Charles A. Larsen, keeper, James A. Downs, assistant keeper; Ragged Point Light Station, Md. | Barge L. B. Adams | Rendered assistance to barge which had sprung a leak. |
| | William McDorman, assistant keeper, Great Shoals Light Station, Md. | Boat | Assistance rendered officer and men of Aviation Corps. |
| | James O. Casey, keeper, Southwest Point Royal Shoal Light Station, N. C. | | Supplied provisions to keeper of Brant Island Shoal Light Station, who was without assistance. |
| | Tender Arbutus | U. S. S. Saranac | Assisted in extinguishing fire and in leading vessel to deep water. |
| | G. M. Willis, sr., keeper, Point Lookout Light Station, Md. | Schooner Sodonia Curley. | Assisted captain of schooner in storing property of beached schooner in lighthouse barn. |
| | Tender Arbutus | Gasoline boat | Rendered assistance to gasoline boat during a storm. |
| | W. G. Rollinson, keeper, Hatteras Light Station, N. C. | Motor boat; U. S. mail boat. | Rendered assistance to disabled motor boat containing 2 men, and floated U. S. mail boat with 5 men aboard. |
| | Tender Arbutus | Motor boat | Rendered assistance to disabled motor boat containing 2 men. |
| | William Yeatman, keeper, Drum Point Light Station, Md. | Aeroplane | Assistance rendered disabled aeroplane containing 2 officers. |
| | C. C. Midgett, assistant keeper, Croatan Light Station, N. C. | Motor boat | Rendered assistance to disabled motor boat with one occupant aboard. |
| | W. J. Tate, keeper, North Landing River Aids, etc., N. C. | Launch | Assistance rendered disabled launch with 2 occupants. |
| | William McDorman, keeper; Gary E. Powell, assistant keeper; Great Shoals Light Station, Md. | Skiff Robert L. Webster. | Rescued skiff, which was adrift and notified owner. |
| | L. V. Gaskill, keeper; T. S. Twiford, assistant keeper; Craighill Front Range Light Station, Md. | Launch | Took in tow a disabled launch with 3 men aboard. |

## SAVING OF LIFE AND PROPERTY BY VESSELS OR EMPLOYEES OF THE LIGHTHOUSE SERVICE DURING THE FISCAL YEAR 1919—Continued.

| District. | Vessel or employee rendering service. | Vessel, etc., aided. | Nature of assistance. |
|---|---|---|---|
| 6th | Relief Light Vessel No. 53 | Navy S. P. No. 923 | Towed disabled patrol boat with light-vessel power boat from Brunswick Light Vessel station to Brunswick, Ga. |
| | Tender Cypress | S. S. Bedminster, U. S. Shipping Board. | Rendered assistance to steamer stranded off Sapelo Sound, Ga. Officers and crew consisting of 35 men were taken to Charleston, S. C. Tender returned to steamer, but was unable to pull it off the shoal. |
| | do | | Assisted in extinguishing fire on piers at water front, Charleston, S. C. |
| | John Lindquist, keeper; Wm. T. Lindquist, second assistant keeper; Mosquito Inlet Light Station, Fla. | S. S. Maple, of Miami S. S. Co. | Assisted in supplying provisions and coal to steamer anchored about 2 miles offshore from light station. |
| | K. E. Kremser, keeper, Georgetown Light Station, S. C. | Aeroplane | Rendered assistance to aeroplane with 6 occupants. |
| | Thomas Knight, keeper, Hillsboro Inlet Light Station, Fla. | Hydroplane | Towed disabled hydroplane, with 3 occupants aboard, to light station. |
| | do | do | Rendered assistance to hydroplane with 2 occupants aboard. |
| | do | Schooner Florence Harvey. | Supplied water to schooner anchored off light station. |
| | do | Hydroplane | Towed disabled hydroplane, with 2 occupants, from beach to S C. 334. |
| | Thomas Knight, keeper; C. Malloy, first assistant keeper; Hillsboro Inlet Light Station, Fla. | do | Towed disabled hydroplane with 2 occupants to light station. |
| | Thomas Knight, keeper, Hillsboro Inlet Light Station, Fla. | do | Assisted in floating and repairing hydroplane. |
| | Thomas Knight, keeper; R. Heisser, first assistant keeper; and R. Nivens, second assistant keeper; Hillsboro Inlet Light Station, Fla. | Motor boat Nightingale. | Floated abandoned motor boat which was filled with water and sand, towed her inside and delivered to owners. |
| 7th | T. A. Moody, keeper, Anclote Keys Light Station, Fla. | Sloop, boat, and schooner. | Rescued 2 men from capsized sloop; towed to safe anchorage a disabled sponge-divers' boat with 2 men in it who were without food or water; and towed to Anclote anchorage a schooner which was lying 6 miles offshore in a disabled condition. |
| | Richard C. Roberts, first assistant keeper, Alligator Reef Light Station, Fla. | Seaplane | Went to assistance of disabled seaplane which had fallen in the water about 10 miles from the light station, dived into shark-infested waters to locate 2 men reported on top or inside of plane, then towed plane about 4 miles when it was taken in tow by a naval boat. |
| | Chas. Johnson, keeper; Robert J. Fine, second assistant keeper; Dry Tortugas Light Station, Fla. | Schooner Curry | Pulled schooner off rock with station motor boat and towed it to Garden Key (Fort Jefferson). |
| 8th | Gilbert S. Bell, mechanician; Robert S. Haskins, laborer; Albert Taylor, assistant keeper; Louis Imsand, mechanic; John B. Cazalas, blacksmith; Jas. M. Jones, blacksmith's helper; E. E. Hanson, laborer; and Dan Callaway, foreman. | | Assisted in extinguishing fire in buoy shed at Mobile Lighthouse Depot, Ala., which threatened to destroy depot and stock. |
| | William Hill, keeper, Calcasieu Range Light Station, La. | | Replaced range light during hurricane and cared for family in vicinity of station whose dwelling had been unroofed by the storm. |
| | Richard F. Steen, keeper, Cat Island Light Station, Miss. | Navy cutter | Rendered assistance to 3 students of Gulf Coast Military Academy, adrift in a Navy cutter; furnished them food and shelter and took them back to the academy. |

## SAVING OF LIFE AND PROPERTY BY VESSELS OR EMPLOYEES OF THE LIGHTHOUSE SERVICE DURING THE FISCAL YEAR 1919—Continued.

| District. | Vessel or employee rendering service. | Vessel, etc., aided. | Nature of assistance. |
|---|---|---|---|
| 8th | Peter Clarisse, keeper, Ship Island Light Station, Miss. | Naval cutter boat | Rendered assistance to 10 recruits from naval station at Gulfport whose boat was blown out to sea during a gale; furnished them shelter at the light station; telephoned naval station for a motor boat to take them back to the naval station. |
| | George W. Bardwell, keeper, Galveston Jetty Light Station, Tex. | Launch Patsy | Rendered assistance to 4 men in disabled launch; towed them to life-saving station at Fort Point. |
| | Niels Nilsen, keeper, Pascagoula River Entrance Lights, Miss., and Frank P. Spratley, keeper, Horn Island Light Station, Miss. | Launch Dixie | Towed disabled launch from Horn Island Light Station to Pascagoula River Entrance Lights, where the owner and his wife were furnished food and shelter and the launch placed in running order. |
| | George W. Anderson, keeper, Halfmoon Reef Light Station, Tex. | Launch Oma B | Rendered assistance to captain of schooner which had stranded near the light station during a gale, and furnished him provisions. |
| | Tender Sunflower | Navy tug Barnett | Endeavored to float tug stranded on east bank of Mississippi River. |
| | Launch No. 130 | Schooner Bertie | Assisted in floating schooner which was ashore on a reef at the entrance to Bayou Lacombe, Lake Pontchartrain, La. |
| | Milton E. Wheelock, keeper, Crooked River Range Light Station, Fla. | Motor launch | Towed disabled launch, with 2 men, 3 women, and 3 children aboard, to light station and furnished food and shelter to women and children. |
| 9th | Tender Lilac | S. S. Balosoro, U. S. Shiping Board. | Towed steamer with valuable cargo aboard from anchorage in open sea to safe anchorage in St. Thomas Harbor, Virgin Islands. |
| | do | Barge | Rescued barge adrift in San Juan Harbor and moored it at the lighthouse dock, it then being turned over to owners. |
| | Keepers of Mona Island Light Station, P. R. | Schooner | Assisted in saving schooner and crew. |
| 10th | Geo. H. Ward, keeper, Sackets Harbor Light Station, N. Y. | Power boat | Assisted occupants of boat which struck rocks and sank and brought women and children safely ashore. |
| | Tender Crocus | Gasoline launch Graceial II. | Recovered launch partly submerged in Lake Erie and delivered it to representative of owner. |
| | Robert C. Graves, keeper; Willie E. Frazier, assistant keeper; Galloo Island Light Station, N. Y. | Power boat Louis Donald. | Towed disabled boat to lighthouse dock and furnished food and shelter to 4 men. |
| | Robert Allen, keeper; Patrick Owens, first assistant keeper; Frank Huntington, second assistant keeper; Presque Isle Pierhead Light Station, Pa. (and wives of Allen and Huntington). | Steamer Tempest, Lawrence S. S. Co., owners. owners. | Assisted in rescue of crew of steamer which foundered in channel off Erie Harbor, Pa. |
| 11th | O. J. Louks, first assistant keeper, Middle Island Light Station, Mich. | Yacht Companion | Took 3 of 15 men on board stranded yacht to coast guard station and reported wreck. |
| | W. A. Burke, keeper, Saginaw River Range Light Station, Mich. | Motor boat Patrice | Took party off stranded boat and floated it next day. |
| | Michael Nolan second assistant keeper, Huron Island Light Station, Mich. | Steamer Vulcan | Took an officer off stranded vessel to report accident and then returned and aided in getting under control a fire which had started on the steamer. |
| 12th | H. Rocheleau, second assistant keeper, Holland Range Light Station, Mich. | Canoe | Rescued 2 persons from capsized canoe and placed them ashore. |
| | L. Beloungea, keeper; A. Keller, second assistant keeper; Ile Aux Galets Light Station, Mich. | Motor boat attached to Squaw Island Light Station, Mich. | Rendered assistance to occupant of disabled boat and provided sail for return to home station. |

## Saving of Life and Property by Vessels or Employees of the Lighthouse Service During the Fiscal Year 1919—Continued.

| District. | Vessel or employee rendering service. | Vessel, etc., aided. | Nature of assistance. |
|---|---|---|---|
| 12th | L. Beloungea, keeper; F. Lauer, first assistant keeper; Ile Aux Galets Light Station, Mich. | Motor boat | Towed disabled boat containing 3 men to station. |
| | L. Beloungea, keeper; F. Lauer, first assistant keeper; A. Keller, second assistant keeper; Ile Aux Galets Light Station, Mich. | do | Towed disabled boat about 1 mile to station and afterwards towed it to mainland. |
| | Peshtigo Reef Light Vessel No. 77, Wis. | Motor boat Wyandotte. | Rendered assistance to boat with 5 persons aboard and provided temporary rudder for steering to port. |
| | Mrs. Ross F. Wright, wife of first assistant keeper, Manitowoc Light Station, Wis. | | Rescued 2 bathers from drowning. |
| | Jas. McCormick, keeper; W. F. Green, first assistant keeper; O. E. Dame, second assistant keeper, South Fox Island Light Station, Mich. | Motor boat Fountain Bros. | Towed disabled boat about 3 miles to station and assisted in repairing propeller. |
| | O. C. McCauley, keeper; Thos. Gatliff, second assistant keeper, Squaw Island Light Station, Mich. | Fishing tug Lillie and May. | Towed disabled vessel about 4 miles to station. |
| | C. J. Graan, keeper; J. E. Mucklian, first assistant keeper; Calumet Pierhead Light Station, Ill. | U. S. Engineer Department motor boat. | Assisted in extinguishing fire on board boat. |
| | W. Ottosen, keeper, Pilot Island Light Station, Wis. | Fish boat Edna | Towed disabled boat to station and assisted in repairing engine. |
| | J. Napiezinski, keeper, Manitowoc Light Station, Wis. | | Assisted in search for body of drowned girl under severe weather conditions. |
| | C. Witzmann, keeper; A. Weber, first assistant keeper, Tail Point Light Station, Wis. | Motor boat G. F. Laviolette. | Rescued 3 men from raft on which they had taken refuge after vessel had capsized and sunk. |
| | L. Hutzler, keeper, Grassy Island Light Station, Wis. | do | Assisted in salvaging portion of cargo after vessel had capsized and sunk. |
| 13th | Tender Dandelion | Steamer St. Paul | Rendered assistance in getting steamer off of sand bar. |
| | do | Steamer Ellen, U. S. Engineer Department. | Assisted in raising steamer which sank at the head of Coon Slough, Upper Mississippi River. |
| 16th | W. A. Shoemaker, keeper, Cape Hinchinbrook Light Station, Alaska. | Gas boat Myrtle H. | Furnished food and shelter to 3 shipwrecked men for 9 days. |
| | George West, keeper, Guard Island Light Station, Alaska. | Gas boat Loey B. | Towed disabled boat, which was in danger of drifting on rocks, to safe anchorage for repairs. |
| | Tender Cedar | Steamer Princess Sophia. | Rendered assistance when vessel was wrecked on Vanderbilt Reef, doing patrol work, transporting searching parties, using wireless, etc. |
| 17th | Tender Heather | Launch May | Towed to Port Townsend, Wash., disabled launch and took man on board tender and cared for him. |
| | Tender Heather and Swiftsure Bank Light Vessel No. 93, Wash. | Boat | While coaling light vessel, cargo boat of tender Heather capsized; prompt action of officers of both vessels resulted in all 7 of crew being saved. |
| 18th | A. C. Anderson, keeper, Santa Cruz Light Station, Calif. | | Attempted to rescue drowning man and finally recovered body. |
| | J. Rankin, keeper, Fort Point Light Station, Calif. | | Rescued 2 boys from drowning. |
| | W. H. Hicks, keeper Mile Rocks Light Station, Calif. | | Rescued from drowning 3 men whose canoe capsized near the station. |
| 19th | Tender Kukui | Schoner Ida May | Towed disabled schooner into harbor. |
| | do | Steamer Santa Cruz. | Pulled stranded steamer off of reef in Honolulu Harbor. |
| | do | Steamer Cathana | Assisted in floating steamer which had grounded on Sand Island, Honolulu Harbor. |
| | Manuel Ferriera, keeper, Barbers Point Light Station, Hawaii. | Fishing sampan | Furnished shelter, dry clothing, and food to 7 persons from shipwrecked sampan. |
| | Tender Kukui | Schooner Kitsap | Searched for schooner wrecked by collision, located derelict, and assisted in destroying same. |

## DAMAGE BY COLLISIONS.

During the fiscal year there were 28 cases of collisions by vessels with aids to navigation, tenders and other lighthouse property, causing damages which have been repaired or paid for by the parties responsible therefor, or proper measures taken by the Lighthouse Service to compel payment by owners of the vessels where such owners or vessels were identified.

During the fiscal year there were three cases of collisions, in which vessels of the Lighthouse Service were found to have been responsible for damage to other vessels or property. Adjustment of claims resulting from these collisions, in the total amount of $160.37, has been made and report submitted to Congress under the provisions of section 4 of the act of June 17, 1910 (36 Stat. 537).

## PUBLICATIONS OF THE LIGHTHOUSE SERVICE.

| Publications. | Date of last edition. | Cost of last edition. | Number distributed. |
|---|---|---|---|
| Light lists: | | | |
| Atlantic and Gulf coasts of United States | Jan. 1, 1919 | $3,890 | 11,799 |
| Pacific coast of United States, etc | do | 640 | 2,504 |
| Great Lakes of United States and Canada | Apr. 1, 1919 | 876 | 1,383 |
| Upper Mississippi River and tributaries | Jan. 15, 1919 | 215 | 1,206 |
| Ohio River and tributaries | Sept. 15, 1918 | 166 | 1,051 |
| Lower Mississippi River and tributaries | Nov. 15, 1918 | 129 | 1,500 |
| Buoy lists: | | | |
| First district | May 1, 1918 | 888 | 1,971 |
| Second district | June 1, 1918 | 757 | 2,128 |
| Third district | May 15, 1919 | 954 | 5,776 |
| Fourth district | June 1, 1919 | 271 | 1,160 |
| Fifth district | May 15, 1919 | 1,104 | 1,175 |
| Sixth district | May 1, 1918 | 387 | 1,206 |
| Seventh district | do | 474 | 1,166 |
| Eighth district | Sept. 1, 1918 | 653 | 3,809 |
| Ninth district | Nov. 15, 1918 | 61 | 2,105 |
| Tenth district | Apr. 1, 1919 | 276 | 1,372 |
| Eleventh district | do | 592 | 1,369 |
| Twelfth district | do | 325 | 1,356 |
| Sixteenth district | June 1, 1919 | 255 | 195 |
| Seventeenth district | do | 304 | 551 |
| Eighteenth district | June 1, 1918 | 229 | .......... |
| Nineteenth district | Feb. 1, 1919 | 128 | 934 |
| Miscellaneous publications: | | | |
| Weekly Notice to Mariners | 1919 | 3,849 | 244,450 |
| Annual Report, Commissioner of Lighthouses | 1918 | 612 | 1,411 |
| Regulations for the United States Lighthouse Service | 1918 | 619 | 448 |
| Medical handbook | 1915 | 633 | 12 |
| Lighthouse Service bulletins | 1919 | 218 | 1,800 |
| Regulations for lighting bridges | 1915 | 202 | 89 |
| Regulations for uniforms | 1912 | 70 | 4 |
| Civil-service regulations | 1913 | 73 | 178 |
| Instructions for cost keeping | 1914 | 120 | 1 |
| Instructions to employees | 1915 | 408 | 20 |
| The United States Lighthouse Service | 1915 | 508 | 137 |

## COST OF PRINTING FOR THE LIGHTHOUSE SERVICE DURING THE FISCAL YEAR 1919.

| | |
|---|---|
| Light lists | $5,157.66 |
| Buoy lists | 4,150.58 |
| Notices to mariners | 3,706.17 |
| Annual report | 612.15 |
| Specifications and other publications | 714.36 |
| Forms, reports, record books, etc | 251.51 |
| Total | 14,592.43 |

## MISCELLANEOUS RECEIPTS.

The following amounts were received by the Lighthouse Service during the year and turned into the Treasury: From sales of property, $25,794.40; from damages to aids to navigation and other property, $3,799.30; from leases and rentals, $5,688.80.

## APPROPRIATIONS FOR THE BUREAU OF LIGHTHOUSES AND THE LIGHTHOUSE SERVICE, SIXTY-FIFTH CONGRESS, THIRD SESSION, 1918–19, AND SIXTY-SIXTH CONGRESS, FIRST SESSION.

| Title. | Act. | Amount. |
|---|---|---|
| Maintenance: | | |
| Salaries of keepers of lighthouses, 1919 | Deficiency, Nov. 4, 1918 | $254,432 |
| Retired pay, Lighthouse Service, 1919 | do | 30,000 |
| Salaries, Bureau of Lighthouses, 1920 | Legislative, Mar. 1, 1919 | 65,430 |
| General expenses, Lighthouse Service, 1920 | Sundry civil, July 19, 1919 | 3,500,000 |
| Salaries of keepers of lighthouses, 1920 | do | 1,300,000 |
| Salaries, lighthouse vessels, 1920 | do | 1,400,000 |
| Salaries, Lighthouse Service, 1920 | do | 380,000 |
| Retired pay, Lighthouse Service, 1920 | do | 45,000 |
| Total for maintenance | | 6,974,862 |
| Special works: | | |
| Fifth lighthouse district, gas buoys | Deficiency, Nov. 4, 1918 | 60,000 |
| Aids to navigation, St. Marys River, Mich | do | 80,000 |
| Repairing and rebuilding aids to navigation, Atlantic coast. | do | 300,000 |
| Extension Rocks Light Station, N. Y | Sundry civil, July 1, 1919 | 10,000 |
| Staten Island Lighthouse Depot, N. Y. (machine shop) | do | 30,000 |
| Riprap protection for light stations, third lighthouse district. | do | 150,000 |
| Point Jiguero Light Station, P. R | do | 24,000 |
| Manitowoc Breakwater Light Station, Wis | do | 9,000 |
| Chicago Harbor Light Station, Ill | do | 6,400 |
| Aids to navigation, Alaska | do | 75,000 |
| Lightkeepers' dwellings | do | 50,000 |
| Total for special works | | 794,400 |
| Grand total | | 7,769,262 |

NOTE.—In addition to the above appropriations, the Navy Department transferred $539,279 to the credit of "General expenses, Lighthouse Service, 1919," and $200,000 to the credit of "Salaries, lighthouse vessels, 1919," and $9,000 to the credit of "Staten Island Lighthouse Depot, N. Y." Allotments were made by the President from the fund for "National security and defense" of $175,000, and $100,000 for Staten Island Lighthouse Depot, N. Y., and aids to navigation, Caribbean Sea, respectively.

## EXPENDITURES DURING THE FISCAL YEAR 1919 FROM APPROPRIATIONS FOR THE LIGHTHOUSE SERVICE.

[Obligations incurred are not included.]

| | |
|---|---|
| Salaries: | |
| Bureau of Lighthouses, 1918 | $2,792.98 |
| Bureau of Lighthouses, 1919 | 53,839.12 |
| Salaries of keepers of lighthouses: | |
| 1918 | 26,192.88 |
| 1919 | 1,113,110.54 |
| Salaries, lighthouse vessels: | |
| 1918 | 55,649.90 |
| 1919 | 1,353,243.55 |
| Salaries, Lighthouse Service: | |
| 1917 | 20.00 |
| 1918 | 4,128.38 |
| 1919 | 363,520.43 |
| General expenses, Lighthouse Service: | |
| 1917 | 66,368.56 |
| 1918 | 704,218.59 |
| 1919 | 2,551,038.58 |
| Increase of compensation, Department of Commerce: | |
| 1918 | 7,851.10 |
| 1919 | 371,575.64 |
| Retired pay, Lighthouse Service: | |
| 1919 | 20,987.65 |
| Total maintenance | 6,694,537.90 |

### SPECIAL WORKS.

| | |
|---|---|
| General: | |
| Repairing and rebuilding aids to navigation, Atlantic coast | 130,425.93 |
| Light vessels for general service | 80,536.58 |
| Lighthouse tender, general service | 250.07 |
| Radio installations on lighthouse tenders | 3,041.87 |
| Oil houses for light stations | 464.03 |

| | |
|---|---|
| First district: | |
| Dog Island Light, Me | $3,111.89 |
| Second district: | |
| Woods Hole Lighthouse Depot, Mass | 1,270.21 |
| Nantucket Harbor Fog Signal, Mass | 5,025.53 |
| Third district: | |
| Staten Island Lighthouse Depot, N. Y. (office) | 7,847.12 |
| Staten Island Lighthouse Depot, N. Y. (wharves) | 33,777.28 |
| Staten Island Lighthouse Depot, N. Y. (Bureau of Yards and Docks) | 9,000.00 |
| Aids to navigation, Hudson River, N. Y | 80,453.91 |
| Aids to navigation, East River, N. Y | 6,603.18 |
| Tender for third lighthouse district | 5.40 |
| Great Salt Pond Light Station, R. I | 16.62 |
| National security and defense, Department of Commerce, 1919 (Tompkinsville) | 16,635.85 |
| Fourth district: | |
| Aids to navigation, Delaware River, Pa. and Del | 9,660.49 |
| Joe Flagger Shoal Light Station, Delaware River | 7,926.04 |
| Fifth district: | |
| Thimble Shoal Light Station, Va | 725.00 |
| Aids to navigation, Chesapeake Bay, Md. and Va | 1,201.80 |
| Aids to navigation, Cape Charles City, Va | 3,524.00 |
| Fifth lighthouse district, gas buoys | 39,695.23 |
| Sixth district: | |
| Tender for engineer, sixth lighthouse district | 562.68 |
| Aids to navigation, St. Johns River, Fla | 7,699.12 |
| Eighth district: | |
| Aransas Pass Light Station, Tex | 10,445.20 |
| Galveston Jetty Light Station, Tex | 315.00 |
| Aids to navigation, Atchafalaya Entrance Channel, La | 4,476.72 |
| Repairing and rebuilding aids to navigation, Gulf of Mexico | 63,030.99 |
| Aids to navigation, Mississippi River, La | 18,090.50 |
| National security and defense, Department of Commerce, 1919 (Caribbean Sea) | 14,380.38 |
| Ninth district: | |
| Navassa Island Light Station, West Indies | 151.62 |
| Point Borinquen Light Station, P. R | 501.33 |
| Tenth district: | |
| Aids to navigation, Ashtabula Harbor, Ohio | 550.20 |
| Aids to navigation, Lorain Harbor, Ohio | 2,530.83 |
| Aids to navigation, Conneaut Harbor, Ohio | 18,309.04 |
| Aids to navigation, Toledo Harbor, Ohio | 321.41 |
| Aids to navigation, Fairport Harbor, Ohio | 995.00 |
| Aids to navigation, Huron Harbor, Ohio | 3,509.70 |
| Eleventh district: | |
| Aids to navigation, Fighting Island Channel, Detroit River, Mich | 4,859.40 |
| Detroit River Lights, Mich | 13.70 |
| Superior Pierhead Range Lights, Wis | 1,837.00 |
| Sand Hills Light Station, Mich | 45,328.72 |
| Aids to navigation, Keweenaw Waterway, Mich | 57,169.72 |
| Detroit Lighthouse Depot, Mich | 14,879.07 |
| Aids to navigation, St. Mary's River, Mich | 1,225.16 |
| Twelfth district: | |
| White Shoal Light Station, Lake Michigan | 545.55 |
| Chicago Harbor Light Station, Ill | 32,818.49 |
| Manitowoc Breakwater Light Station, Wis | 19,859.30 |
| Sixteenth district: | |
| Aids to navigation, Alaska | 11,778.28 |
| Cape St. Elias Light Station, Alaska | 103.20 |
| Depot for sixteenth lighthouse district | 48,589.95 |
| Seventeenth district: | |
| Aids to navigation, Puget Sound, Wash | $783.83 |
| Kellett Bluff Light Station, Wash | 35,371.60 |
| Aids to navigation, Wash. and Oreg | 16,111.30 |

| | |
|---|---|
| **Nineteenth district:** | |
| Aids to navigation, Pearl Harbor, Hawaii | $7,741.91 |
| Total, special works | 880,958.40 |
| Total, maintenance appropriations | 6,694,537.90 |
| Total, special works | 880,958.40 |
| Grand total | 7,575,496.30 |

## ITEMIZED ESTIMATES OF APPROPRIATIONS FOR THE FISCAL YEAR 1921, AND ITEMIZED STATEMENT OF EXPENDITURES FOR THE FISCAL YEAR 1919, AS REQUIRED BY THE ACT OF CONGRESS APPROVED JUNE 25, 1910 (36 STAT., 755).

[The expenditures herein stated are in part estimated, owing to the fact that all obligations incurred for the year 1919 have not yet been settled. Articles of supplies purchased for general stock have also been distributed, approximately, to features to be benefited. This table refers to appropriations made in the sundry civil appropriation act and does not include Bureau salaries in Washington nor the cost of publications, otherwise provided for. This statement contains also amounts for salaries and wages under certain items which are shown separately in the Book of Estimates, 1921.]

| Item. | Estimate, 1921. | Expenditures, 1919. |
|---|---|---|
| GENERAL EXPENSES, LIGHTHOUSE SERVICE. | | |
| Lights and fog signals: | | |
| Rations and provisions | $248,700 | $247,757 |
| Fuel and rent for keepers | 84,000 | 82,230 |
| General supplies | 300,000 | 290,903 |
| Repairs and improvements, including grounds and outbuildings | 400,000 | 394,973 |
| Establishing lights and fog signals, including sites | 35,000 | 18,946 |
| Necessary additional land for light stations | 1,500 | .......... |
| Oil and carbide houses | 2,500 | 1,227 |
| Incidental expenses | 15,000 | 24,071 |
| Daymarks and spindles: | | |
| Establishment, including sites | 4,000 | 3,521 |
| Repairs and improvements | 2,500 | 1,349 |
| Incidental expenses | 600 | 571 |
| Post lights: | | |
| Establishment | 2,000 | 1,228 |
| Wages of laborers attending lights | 260,000 | 248,184 |
| Supplies | 40,000 | 39,221 |
| Repairs and improvements | 15,000 | 11,822 |
| Incidental expenses | 2,200 | 2,507 |
| Buoys: | | |
| Establishment | 200,000 | 190,010 |
| Supplies | 65,000 | 64,176 |
| Repairs | 75,000 | 78,953 |
| Incidental expenses | 4,000 | 4,227 |
| Tenders: | | |
| Rations and provisions | 300,000 | 289,125 |
| Supplies | 625,000 | 609,563 |
| Repairs | 550,000 | 493,504 |
| Incidental expenses | 18,000 | 26,749 |
| Light vessels: | | |
| Rations and provisions | 155,000 | 143,807 |
| Supplies | 160,000 | 151,168 |
| Repairs | 275,000 | 252,211 |
| Incidental expenses | 6,000 | 6,359 |
| Depots: | | |
| Pay of laborers and mechanics | 90,000 | 82,451 |
| Rent | 5,500 | 5,120 |
| Supplies | 70,000 | 65,349 |
| Repairs and improvements | 90,000 | 77,277 |
| Incidental expenses | 15,000 | 22,110 |
| Offices: | | |
| Technical books and periodicals | 500 | 335 |
| GENERAL EXPENSES, LIGHTHOUSE SERVICE—continued. | | |
| Offices—Continued. | | |
| Stationery and office supplies | $40,000 | $50,226 |
| Telegraph and telephone | 8,000 | 7,830 |
| Traveling expenses and mileage | 30,000 | 28,394 |
| Rent | 3,000 | 2,750 |
| Freight, expressage, and cartage | 95,000 | 96,930 |
| Incidental expenses | 7,000 | 8,250 |
| Total | 4,300,000 | 4,125,441 |
| Appropriation, 1920, $3,500,000 | | |
| Appropriation, 1919, $3,500,000. | | |
| SALARIES OF KEEPERS OF LIGHTHOUSES. | | |
| Salaries of lighthouse keepers | 1,330,000 | 1,147,836 |
| Appropriation, 1920, $1,300,000. | | |
| Appropriation, 1919, $1,194,432. | | |
| SALARIES, LIGHTHOUSE VESSELS. | | |
| Salaries and wages, lighthouse tenders | 1,310,829 | 882,260 |
| Salaries and wages, light vessels | 789,171 | 531,715 |
| Total | 2,100,000 | 1,413,975 |
| Appropriation, 1920, $1,400,000. | | |
| Appropriation, 1919, $1,265,000. | | |
| SALARIES, LIGHTHOUSE SERVICE. | | |
| Salaries, authorized district office, technical and depot forces | 490,000 | 368,012 |
| Appropriation, 1920, $380,000. | | |
| Appropriation, 1919, $380,000. | | |

NOTE.—The expenditures shown include reimbursements from Navy Department for part of maintenance expenses of vessels and stations transferred temporarily to Navy by Executive order, approximately $625,441, under appropriation "General expenses, Lighthouse Service," and $148,975 under appropriation, "Salaries, Lighthouse Service." Under appropriation "General expenses, Lighthouse Service," it is proposed during the fiscal year 1920 to authorize per diem in lieu of subsistence, pursuant to the act of Aug. 1, 1914, at rates of from $2 to $4.

## SUMMARY OF ESTIMATES OF APPROPRIATIONS FOR THE LIGHTHOUSE SERVICE FOR THE FISCAL YEAR 1921.

### FOR GENERAL MAINTENANCE OF THE LIGHTHOUSE SERVICE.

| | |
|---|---|
| Salaries, Bureau of Lighthouses | $79,668.40 |
| General expenses, Lighthouse Service | 4,300,000.00 |
| Salaries, Lighthouse Service | 490,000.00 |
| Salaries, keepers of lighthouses | 1,330,000.00 |
| Salaries, lighthouse vessels | 2,100,000.00 |
| Retired pay, Lighthouse Service | 85,000.00 |
| Total | 8,384,668.40 |

### FOR SPECIAL WORKS.

Group 1. Works urgently necessary for the safety or immediate needs of navigation and for the preservation of existing structures or equipment, for the full utilization of other public improvements, or for the efficient equipment of the Lighthouse Service:

| | | |
|---|---|---|
| 1. Constructing or purchasing and equipping tenders and lightvessels | | $5,000,000.00 |
| 2. Constructing or purchasing and equipping tenders and lightvessels | | 760,000.00 |
| 3. Diamond Shoal, N. C., lightvessel | | 450,000.00 |
| 4. Hawaiian Islands Lighthouse Depot, construction and equipment | | 120,000.00 |
| 5. Lighthouse depot for fifth district, enlargement, improvement, or establishment of new depot | | 350,000.00 |
| 6. Virgin Islands, West Indies, aids to navigation | | 50,000.00 |
| 7. Potomac River, Md., aids to navigation | | 95,000.00 |
| 8. Lighthouse depot for eighth district, construction | | 132,750.00 |
| 9. Charleston Lighthouse Depot, S. C., improvements | | 60,000.00 |
| 10. Lighthouse depot for seventh district, establishing | | 250,000.00 |
| 11. Conneaut Harbor, Ohio, completing light and fog-signal station | | 19,600.00 |
| 12. Ludington, Mich., aids to navigation | | 75,000.00 |
| 13. Tampa Bay, Fla., aids to navigation | | 17,500.00 |
| 14. Delaware Bay entrance, improvement of aids to navigation | | 148,500.00 |
| 15. Newport, R. I., lighthouse depot | | 82,300.00 |
| 16. California and Nevada, aids to navigation | | 44,750.00 |
| 17. Goat Island Lighthouse Depot, Calif., improvement | | 18,000.00 |
| 18. Cape Spencer, Alaska, establishment of light and fog-signal station | | 150,000.00 |
| 19. Galveston Jetty, Tex., fog signal | | 6,500.00 |
| 20. Additional buoys for fifth lighthouse district | | 44,600.00 |
| 21. Staten Island Lighthouse Depot, N. Y., improvements | | 65,000.00 |
| 22. Detroit (Mich.) Lighthouse Depot | | 50,000.00 |
| Authorized by law | $1,423,000 | |
| Not authorized | 6,566,500 | |
| Total, group 1 | | 7,989,500.00 |

Group 2. Works considered essential for the needs of navigation and the equipment of the Lighthouse Service, and which it is recommended be undertaken as resources permit, are submitted with estimates of cost. (These items have been selected from a much larger number of recommendations submitted by the superintendents of the lighthouse districts and others.)

| | |
|---|---|
| 23. Point Pinos Light Station, Calif., improvement | 40,000.00 |
| 24. Woods Hole, Mass., lighthouse depot, improvements | 15,000.00 |
| 25. Michigan Island, Wis., establishment of light and fog-signal station | 85,000.00 |
| 26. Kauhola Point Light Station, Hawaii, improvement | 20,000.00 |
| 27. Santa Barbara Light Station, Calif., improvements | 40,000.00 |
| 28. Portage Lake, Mich., establishment of light and fog-signal station and improvement of aids | 100,000.00 |
| 29. Ram Island, Me., establishment of light | 5,400.00 |
| 30. Cape Kumukahi, Hawaii, establishment of light | 22,000.00 |
| 31. Henderson Point, Me., establishment of light and fog signal | 7,500.00 |

Group 2—Continued.

| | |
|---|---|
| 32. Port Real, P. R., establishment of light station | $40,000.00 |
| 33. Nine Mile Point, Mich., establishment of light and fog-signal station | 50,000.00 |
| 34. Grays Harbor Light Station, Wash., improvements | 20,000.00 |
| 35. Alaska, aids to navigation | 75,000.00 |
| 36. Lake Champlain, N. Y. and Vt., improvements | 150,000.00 |
| 37. Sag Harbor, N. Y., improvements | 45,700.00 |
| 38. Alaska, improvements | 77,000.00 |
| 39. Depot for second lighthouse district | 123,645.00 |
| 40. Great Salt Pond Light Station, R. I., to complete | 53,000.00 |
| 41. Norfolk, Va., to Beaufort, N. C., aids to navigation | 63,000.00 |
| 42. Fairport Harbor, Ohio, aids to navigation | 35,500.00 |
| 43. Lansing Shoal, Mich., establishment of light and fog-signal station | 304,000.00 |
| 44. Two Rivers, Wis., improvements | 6,000.00 |
| Total, group 2 (not included in total of estimates) | 1,377,745.00 |

RECAPITULATION.

| | |
|---|---|
| For general maintenance of the Lighthouse Service | 8,384,668.40 |
| For special works: Group 1 | 7,989,500.00 |
| Total | 17,751,913.40 |

## DETAILED ESTIMATES FOR MAINTENANCE, 1921.

### BUREAU OF LIGHTHOUSES.

| | |
|---|---|
| Salaries | $79,668.40 |

### GENERAL EXPENSES, LIGHTHOUSE SERVICE.

For supplies, repairs, maintenance, and incidental expenses of lighthouses and other lights, beacons, buoyage, fog signals, lighting of rivers heretofore authorized to be lighted, light vessels, other aids to navigation, and lighthouse tenders, including the establishment, repair, and improvement of beacons and day marks and purchase of land for same; the establishment of post lights, buoys, submarine signals, and fog signals; the establishment of oil or carbide houses not to exceed $10,000: *Provided*, That any oil or carbide house erected hereunder shall not exceed $550 in cost; the construction of necessary outbuildings at a cost not exceeding $500 at any one light station in any fiscal year; the improvements of grounds and buildings connected with light stations and depots; restoring light stations and depots and buildings connected therewith: *Provided*, That such restoration shall be limited to the original purpose of the structures; wages of persons attending post lights; pay of temporary employees and field force while engaged on works of general repairs and maintenance and pay of laborers and mechanics at lighthouse depots; rations and provisions or commutation thereof for keepers of lighthouses, working parties in the field, officers and crews of light vessels and tenders, and officials and other authorized persons of the Lighthouse Service on duty on board of such tenders or vessels; and money accruing from commutation for rations and provisions for the above-named persons on board of tenders and light vessels or in working parties in the field may be paid on proper vouchers to the person having charge of the mess of such vessel or party, reimbursement under rules prescribed by the Secretary of Commerce of keepers of light stations and masters of light vessels and of lighthouse tenders for rations and provisions and clothing furnished shipwrecked persons who may be temporarily provided for by them, not exceeding in all $5,000 in any fiscal year; fuel and rent of quarters where necessary for keepers of lighthouses; the purchase of land sites for fog signals; the rent of necessary ground for all such lights and beacons as are for temporary use or to mark changeable channels and which in consequence can not be made permanent; the rent of offices, depots, and wharves; traveling expenses, mileage, library books for light stations and vessels, and technical books and periodicals not exceeding $1,000; traveling and subsistence expenses of teachers while actually employed by States or private persons to instruct the children of keepers of lighthouses; and for all other contingent expenses of district offices and depots and not exceeding $8,500 for contingent expenses of the Office of the Bureau of Lighthouses in the District of Columbia, $4,300,000.

Hereafter the benefits of the Public Health Service accorded to light keepers and ssistant light keepers of the Lighthouse Service under the provisions of the act of

August 28, 1916 (39 Stat., 538), shall also include medical relief without charge to such employees at other than hospitals or stations of the Public Health Service, under regulations promulgated by the Secretary of the Treasury and the Secretary of Commerce.

Hereafter post-lantern lights and other aids to navigation may be established and maintained, in the discretion of the Commissioner of Lighthouses, out of the annual appropriations for the Lighthouse Service on the Yukon River and its tributaries, Alaska.

Hereafter the benefits of section 6 of the act of June 20, 1918 (40 Stat., 608), providing for the retirement of officers and employees of the Lighthouse Service, shall be available, under rules prescribed by the Secretary of Commerce, at the same rate of compensation as provided in said act, for the same classes of officers and employees of the Lighthouse Service, who by reason of disability incident to their work and not the result of their own vicious habits have lost their efficiency for active work before reaching the age or having the length of service required by existing law.

Hereafter the Commissioner of Lighthouses, subject to the approval of the Secretary of Commerce, is authorized to consider, ascertain, adjust, and determine all claims for loss or damage, where the amount of the claim does not exceed $500, to the personal property of officers and employees of the Lighthouse Service hereafter occasioned by storm, fire, shipwreck, or other extraordinary cause, not due to the negligence or voluntary act of the owner of such property, and report the amounts so ascertained and determined to be due the claimants to Congress at each session thereof through the Treasury Department for payment as legal claims out of appropriations that may be made by Congress therefor; provided that the property is lost or damaged at stations, depots, or on vessels of the Lighthouse Service, or in transit by reason of the official duties of such persons.

NOTE.—The amount estimated for is $800,000 in excess of the appropriation for the fiscal year 1920, made necessary on account of the general expansion of the Service and the great advance in the cost of all commodities and services.

An increase of appropriation is considered necessary because of the extraordinary advance in the price of labor and materials, on account of the increase in numbers of aids required for the safety of navigation, and to keep the Lighthouse Service in an economical state of repair and efficiency. The total number of aids was increased in 1919 from 15,676 to 16,076, an increase of 400, or 2.6 per cent. In order to keep pace with the constant development of commerce proper provision for maintenance and repair as well as for the establishment of necessary additional minor aids frequently requested by mariners should be made. It has been found necessary to estimate on an increase for all items in the appropriations covering the purchase of supplies and materials, due to the continued steady general advance in prices. The additional amount requested is conservative in view of the circumstances.

(See p. 755 for itemized estimate.)

The appropriation for the fiscal year 1919 was $3,500,000, but it was necessary to supplement this amount to the extent of approximately $625,000 from appropriations of the Navy Department on account of the maintenance of vessels and stations of the Lighthouse Service transferred to that Department as authorized by the act of August 29, 1916 (39 Stat., 614). These vessels and stations were retransferred to the Lighthouse Service on July 1, 1919, and Navy Department funds will not be available for obligations incurred thereafter. The amount requested for 1921 is only about $175,000 more than the amount available and expended in 1919, but this is necessary because of continued high costs, and the fact that insufficient funds the past few years has prevented the lighthouse property being maintained at a proper standard. There have been especially large increases, still continuing, in the expense of vessel repairs and cost of subsistence. Conservative estimates by superintendents of lighthouses for the necessary work in their districts for the fiscal year 1921, exclusive of expenses under control of the Bureau in Washington, aggregate nearly $1,500,000.

The foregoing estimate of appropriation for "General expenses, Lighthouse Service" provides for a change in language from "laborers attending post lights" to "persons attending other lights." The proposed expression more appropriately and accurately covers the conditions intended to be provided for and is recommended as an improvement in the language of the appropriation act.

The act of August 28, 1916 (39 Stat., 538), provided for medical relief without charge for light keepers and assistant light keepers of the Lighthouse Service, at hospitals and stations of the Public Health Service under the rules and regulations governing the care of seamen of the merchant marine. The hospitals and stations of the Public Health Service are for the most part located at the principal ports, and while convenient for the use of seamen are inaccessible for a large number of lighthouse keepers who are stationed at remote and isolated points. Many keepers are, therefore, unable to avail themselves of the benefits of the legislation heretofore enacted. It is accordingly recommended that the Public Health Service be authorized to provide medical relief for light keepers and assistant light keepers without charge at other than hospitals and stations of the Public Health Service. The Secretary of the Treasury in letter of May 28, 1919, to the Secretary of Commerce concurred in the recommendation for such legislation.

Authority is also requested to cover the establishment and maintenance of post lantern lights and other aids to navigation on the Yukon River and its tributaries, Alaska. The waters of the Yukon delta are already being marked, but congressional authority is required for the Lighthouse Service to extend its jurisdiction to the nontidal waters of these rivers. Navigation of the Yukon River is increasing each year, and as it is navigable for a long distance a great many lights and daymarks are required to safeguard the shipping that passes over it.

The act of June 20, 1918, which has now been in operation one year, providing for voluntary retirement at the age of 65 after 30 years service, and compulsory retirement at the age of 70, for certain classes of employees of the Lighthouse Service has proved beneficial both to the men eligible to retirement and to the Service in replacing such men with younger and more capable employees. Still greater efficiency, however, will result, and hardship to deserving employees will be avoided, if the same benefits are extended to persons who become disabled from efficiently performing their duties by reason of disability incident to their work, such disability being distinct from that caused by injury received in the line of duty, for which compensation is now provided by law. The legislation proposed herein restricts the benefit to the same classes of employees as specified in the act of June 20, 1918.

Light stations are for the most part situated at remote, isolated points where, in case of severe storm, tidal wave, fire, or other calamity, it is difficult or impossible to obtain assistance for the saving of property.

The light keepers in such emergencies, faithful to their duties and to the call of humanity, invariably have devoted themselves to the maintenance of the lights, the saving of public property, or to the protection or rescue of human life. As a result their own property has sometimes been destroyed or seriously damaged. This may represent the accumulations of a lifetime and a serious loss. The furnishings and equipment of light stations provided by the Government are designed only for actual necessities for the performance of a keeper's duties, and keepers must necessarily have personal property at the station. Similar conditions exist with reference to men on lighthouse vessels, though the personal property in such cases is generally confined to personal apparel.

The number of such cases has not been great and the enactment of the proposed legislation would not involve the Government in any great expenditure, but to the individuals concerned it is a matter of great importance; and when a case does arise, it carries a strong appeal, as it is not infrequently accompanied by some striking act of heroism. Congress has in the past occasionally passed special legislation reimbursing employees of the Lighthouse Service for their personal property lost or destroyed, but the process of securing such legislation is slow and in the majority of cases has failed, and the present lack of system consequently results in very unequal justice. Section 4 of the act of June 17, 1910 (36 Stat., 537), conferred upon the Commissioner of Lighthouses the authority to adjust, determine, etc., claims for damages, not exceeding $500, arising out of collisions for which lighthouse vessels are responsible. This provision has worked satisfactorily, enabling the Government to settle with claimants with reasonable promptness and relieving Congress of the annoyance of many petty claims; and the expenditure of money involved has been very small. Similar legislation to cover claims for losses of private property by lighthouse employees, will, it is believed, be equally beneficial, and the conditions and limitations proposed are practically the same. Congress has already provided by law for reimbursement for losses sustained by men in the military service (Mar. 3, 1885; 23 Stat., 350), and in the naval service (Mar. 2, 1895; 28 Stat., 962).

*Salaries, keepers of lighthouses.*—For salaries of not exceeding 1,800 lighthouse and fog-signal keepers and persons attending other lights, exclusive of post lights, $1,330,000.

NOTE.—The foregoing estimate calls for an increase of $30,000 over the appropriation of $1,300,000 made for this purpose for the fiscal year 1920 and is arrived at as follows:

| | |
|---|---|
| 1,500 keepers and assistant keepers at average pay of $840 | $1,260,000 |
| Persons attending other lights | 92,367 |
| | 1,352,367 |

(See p. 755 for itemized estimate.)

*Salaries, lighthouse vessels.*—For salaries and wages of officers and crews of light vessels and lighthouse tenders, including temporary employment when necessary, $2,100,000.

NOTE.—The amount estimated for is $700,000 in excess of the appropriation for the fiscal year 1920, and is caused by the necessity of meeting the pay scales established by the U. S. Shipping Board for vessels of the merchant marine; otherwise it would be impossible to man the vessels of the Lighthouse Service.

| | |
|---|---|
| Authorized base pay, August, 1919 | $1,920,744 |
| Further increase necessary to meet Shipping Board scale for officers, 489 officers at average of $300 | 146,700 |
| Further increases for crews | 32,556 |
| Total | 2,100,000 |

(See p. 755 for itemized estimate.)

*Salaries, Lighthouse Service.*—For salaries of 17 lighthouse superintendents, and of clerks and other authorized permanent employees in the district offices and depots of the Lighthouse Service, exclusive of those regularly employed in the office of the Bureau of Lighthouses, District of Columbia, $490,000. Hereafter the annual salaries of superintendents of lighthouses, excepting the superintendent of the third lighthouse district, whose salary shall be $4,500, shall not exceed an average of $4,000.

NOTE.—An increase of $110,000 over the appropriation for the fiscal year 1920 is submitted, consisting of the following:

| | |
|---|---|
| Increase in the compensation of superintendents of lighthouses, authorization requested, 16 superintendents, at $1,000 each and 1 at $900 | $16,900 |
| Additional employees (2 clerks, 1 assistant superintendent, 2 watchmen, and 1 assistant depot keeper) | 10,000 |
| Proposed increases in the pay of district employees, in order to meet the general advance in compensation, 288 persons, at an average of $300 each | 86,400 |
| Total | 113,300 |

The item of $10,000 is occasioned by the general growth of the service in order that work of the districts may be dispatched promptly.

(See p. 755 for itemized estimate.)

*Retired pay, Lighthouse Service.*—For retired pay of officers and employees, Lighthouse Service, $85,000.

NOTE.—The act of June 20, 1918, provides, "That hereafter all officers and employees engaged in the field service or on vessels of the Lighthouse Service, except persons continuously employed in district offices or shops, who shall have reached the age of sixty-five years, after having been thirty years in the active service of the Government, may at their option be retired from further performance of duty; and all such officers and employees who shall have reached the age of seventy years shall be compulsorily retired from further performance of duty: *Provided*, That the annual compensation of persons so retired shall be a sum equal to one-fortieth of the average annual pay received for the last five years of service for each year of active service in the Lighthouse Service or in a department or branch of the Government having a retirement system, not to exceed in any case thirty-fortieths of such average annual pay received: *Provided further*, That such retirement pay shall not include any amount on account of subsistence or other allowance."

The amount required under this appropriation will necessarily increase gradually for a few years, as the number of persons annually becoming eligible to the benefit is greater than the number of retired employees who decease. The appropriation for 1919 was $30,000, for 1920, $45,000, and $85,000 is estimated for 1921. Eventually, however, the amount required will become practically stationary.

## DETAILED ESTIMATES FOR SPECIAL WORKS, 1921.

### GROUP No. 1.

Works urgently necessary for the safety or immediate needs of navigation and for the preservation of existing structures or equipment, for the full utilization of other public improvements, or for the efficient equipment of the Lighthouse Service.

No. 1. *Lighthouse vessels, general service.*—Constructing or purchasing and equipping lighthouse tenders and light vessels for the Lighthouse Service, $5,000,000.

NOTE.—Careful estimates and examinations as to the condition and further serviceability of vessels of the Lighthouse Service, show that it is very necessary to take prompt measures for replacing the older and wornout vessels of the Service. Immediate provision should be made for 17 vessels covered by this item in addition to the 3 vessels provided under the two following items in these estimates. This is considered indispensible, not only to the efficient operation of the Lighthouse Service in the protection of shipping, but for the reasonable safeguarding of the lives of those employed on vessels of this Service. The extent of the work required at this time is due to lack of sufficient appropriations for a number of years back, to keep up a proper rebuilding program, and to war conditions.

In view of the time required to design, contract for, build, and complete vessels, the whole of this plan should be provided for at the earliest practicable date. A full statement of this important need is made on pages 696 to 701 of this report.

| | |
|---|---|
| 3 tenders at $400,000 each | $1,200,000 |
| 1 tender for rivers | 100,000 |
| 10 light vessels at $335,000 each | 3,350,000 |
| 3 light vessels at $160,000 each | 480,000 |
| Total | 5,130,000 |

No. 2. *Lighthouse tenders and light vessels.*—Constructing or purchasing and equipping lighthouse tenders and light vessels to replace vessels worn out in service in the third, fifth, and eighth lighthouse districts, or for use in the Lighthouse Service generally, $760,000.

NOTE.—This vessel construction was authorized in the act of June 20, 1918 (40 Stat., 607), but no appropriation has been made therefor. This authorization was to provide vessels covered by several earlier estimates; under present conditions it is believed the amount will probably build two vessels. It is urgently necessary to replace at the earliest practicable time the tender *Gardenia* in the third district, and the tender *Jessamine* in the fifth district. The former has been condemned and put out of commission; the latter is a side-wheel tender, 38 years old, which can not much longer be kept in commission. A full statement of the urgent necessity for replacement of vessels in the Lighthouse Service is given on pages 696 to 701 of this report, including these two vessels, which are in addition to the vessels covered by the preceding item.

| | |
|---|---|
| 1 tenders at $400,000 each (or 1 tender and 1 light vessel, if funds not sufficient) | $800,000 |

No. 3. *Diamond Shoal (N. C.) Light Vessel.*—Constructing and equipping a light-vessel for station off Diamond Shoal, N. C., $450,000.

NOTE.—Diamond Shoal Light Vessel No. 71 was sunk on this station by an enemy submarine on August 6, 1918, and it is very important from a maritime point of view that a properly equipped light vessel be constructed as soon as practicable to replace the vessel formerly on station. Diamond Shoal off Cape Hatteras is one of the most important and most exposed light vessel stations on the coast of the United States or in the world.

This vessel is included in the statement on pages 796 to 701 of this report, on the urgent necessity for replacement of vessels in the Lighthouse Service, and is in addition to the vessels in the two preceding items.

No. 4. *Hawaiian Islands lighthouse depot.*—Constructing and equipping a lighthouse depot at Honolulu, Hawaii, $120,000.

NOTE.—The act of August 28, 1916 (39 Stat., 538), authorized $90,000 for this work, but no appropriation was made therefor. The greatest need in this district is an adequate lighthouse depot. At present the depot is in a temporary rented building, costing $100 per month, subject to vacating on short notice, to which the Service was recently compelled to move from the location on Channel wharf. This building is about one-third of a mile from the lighthouse wharf, which will result in considerable cartage expense. Moreover, the present location and building are not suitable for a lighthouse depot. The Lighthouse Service now has the necessary sites for its proposed depot in the nineteenth district, consisting of water front with small wharf in Honolulu and 1¼ acres on Sand Island, across the harbor, which is to be utilized for a buoy depot.

It is proposed to build the present wharf out to the 140-foot slip line and extend it to a total length of 250 feet, making a total area of about 18,125 square feet, 8,000 of which will be new reinforced-concrete wharf on piles. General storehouse, machine and repair shop and oil house to be located on this wharf. On Sand Island site it is intended to erect a wharf of 30 by 100 feet on harbor line, build a continuation to wharf in the form of a concrete floor on the ground, and erect a 50 by 100 foot buoy shed. A depot keeper's dwelling to be erected as second story to storehouse. Detailed estimate:

| | |
|---|---|
| Improvement and enlargement of former Naval Wharf, Honolulu— | |
| Excavation and fill, 1,000 cubic yards, at $1.50 per cubic yard | $1,500 |
| Retaining wall, reinforced concrete (1½ by 4 feet), 155 linear feet, at $6 per linear foot | 930 |
| Sea wall, reinforced concrete (2½ by 8 feet), 275 linear feet, at $18 per linear foot | 4,950 |
| Water and waste pipe (furnish, lay, and cover), 600 linear feet, at $1.87 per linear foot | 1,120 |
| Improvement old wharf, grading and concrete paving, 4,500 square feet, at $0.60 per square foot | 2,700 |
| New reinforced concrete wharf, on piles, 8,000 square feet, at $3.60 per square foot | 28,800 |
| Buoy wharf, Sand Island, reinforced concrete (30 by 100 feet), 3,000 square feet, at $3.60 per square foot | 10,800 |
| General storehouse, reinforced concrete, 75,000 cubic feet, at $0.43 per cubic foot | 32,250 |
| Machine and blacksmith shop, reinforced concrete, 20,000 cubic feet, at $0.43 per cubic foot | 8,600 |
| Oil house, 7,500 cubic feet, at $0.24 per cubic foot | 1,800 |
| Buoy repair and carpenter shop sheds, 2,500 square feet, at $1.56 per square foot | 3,900 |
| Buoy shed, on concrete-paved floor, Sand Island (50 by 100 feet), 5,000 square feet, at $2.16 per square foot | 10,800 |
| Equipment, general depot and buoy shed, Sand Island | 1,000 |
| Equipment, machine, carpenter, and blacksmith shop, lot | 5,000 |
| Keeper's dwelling, Sand Island, 12,500 cubic feet, at $0.36 per cubic foot | 4,500 |
| Improvement of grounds, Sand Island | 1,350 |
| Total | 120,000 |

No. 5. *Depot for fifth lighthouse district.*—**Enlarging and improving the lighthouse depot at Portsmouth, Va., in the fifth lighthouse district, or establishing a new depot, $350,000.**

Note.—The act of June 20, 1918 (40 Stat., 607), authorized this work, but no appropriation was made therefor. The present lighthouse depot at Portsmouth, Va., is entirely inadequate to the needs of the fifth district, both in area and in water front. This depot is the principal supply station for the lighthouse work of Chesapeake Bay and the coast from Maryland to North Carolina, with the sounds and rivers. The increasing maritime and naval importance of the vicinity of Norfolk makes it urgent that a suitable depot be established promptly. It is the principal depot of one of the largest lighthouse districts, and is the headquarters for five tenders and two light vessels during the greater part of the year. The aggregate length of these vessels is over 1,000 feet; the total wharf frontage is only 240 feet, except 200 feet in a narrow slip available for small light-draft vessels only. The operation of tenders is much hampered by this limited frontage, the delay caused by waiting to discharge or receive cargo being estimated to cost the Lighthouse Service not less than $25,000 a year. The very small area available for buoy storage necessitates much otherwise unnecessary handling of heavy buoys and appendages at large cost of time and money. The available wharf frontage of this depot should be doubled, and the area increased by several acres. This may be done by purchase of a new and larger site, or by purchase of adjacent property. The present buildings are mainly antiquated wooden structures. They constitute a fire menace and should be replaced by modern fireproof buildings. Detailed estimate:

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|---|---|
| Site, 500 feet water front, at $250 per front foot | $125,000 |
| Wharf, at $2 per square foot (50 by 700 feet) | 70,000 |
| Track, at $2.50 per linear foot (2,000 linear feet) | 5,000 |
| Concrete bulkhead, at $20 per cubic yard (1,820 cubic yards) | 36,400 |
| Filling and grading, at $3 per cubic yard (7,500 cubic yards) | 22,500 |
| Concrete paving, at $0.35 per square foot (90,000 square feet) | 31,500 |
| Water mains in place, at $2.50 per linear foot (1,000 linear feet) | 2,500 |
| Electric lighting, power, wiring, and conduits | 2,000 |
| Chemical fire engines, at $1,050 each (2) | 2,100 |
| Traveling crane (1) | 6,000 |
| Buoy skids and chain platform, at $1.25 per square foot (50 by 160 feet) | 10,000 |
| Miscellaneous equipment | 8,000 |
| Storehouse, at $0.25 per cubic foot (100,000 cubic feet) | 25,000 |
| Machine, blacksmith, and carpenter shops, at $0.25 per cubic foot (60,000 cubic feet) | 15,000 |
| Coal shed (80,000 cubic feet), at $0.15 per cubic foot | 12,000 |
| Acetylene generating and compressing plant | 5,000 |
| Total | 378,000 |

No. 6. *Virgin Islands, West Indies, aids to navigation.*—**Establishing and improving aids to navigation in the Virgin Islands of the United States, and adjacent waters, West Indies, $50,000.**

Note.—The act of June 20, 1918 (40 Stat., 608), authorized this work, but no appropriation was made therefor. By Executive order of July 20, 1917, the lighthouse service in the Virgin Islands, West Indies, acquired by the United States by treaty from Denmark, was transferred to and placed under the jurisdiction of the United States Lighthouse Service. The aids to navigation in these islands are not extensive and will require additions and improvements to make the waters safe and to provide for increasing commerce. It is proposed to provide four unwatched gas lights, five new buoys, as well as additional aids as may be necessary after further study and developments, and to place existing lighthouse property in a good condition of repair. The Governor of the Virgin Islands, on July 15, 1919, wrote the Secretary of Commerce urging the importance of improvement of aids to navigation in the Virgin Islands. Detailed estimate:

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|---|---|
| 4 unwatched lights, tower 25 feet high, at $5,000 each | $20,000 |
| 5 buoys with moorings, at $1,000 each | 5,000 |
| Relief and spare equipment for lights and buoys | 5,000 |
| Repairs to existing property | 10,000 |
| Additional aids to navigation, as necessary | 10,000 |
| Total | 50,000 |

No. 7. *Potomac River, Md., aids to navigation.*—**Improving the aids to navigation and establishing new aids on the Potomac River, Md., $95,000.**

Note.—The act of June 20, 1918 (40 Stat., 608), authorized this work, but no appropriation was made therefor. The Potomac River is the poorest lighted and marked of the important navigable rivers of the United States, a condition which should not be allowed to continue, because of its relation to the National Capital and many Government activities, and its increased navigational importance. There are urgent requests from steamship companies for improvements in the lighting and marking of the Potomac River.

The Potomac River, from Maryland Point to Washington, about 40 nautical miles, is now lighted by only four gas buoys, five minor lights, and one lighthouse. The gas buoys are of low candlepower and are of necessity removed from station for several months in the winter on account of ice conditions. The minor lights are all fixed white or red lights of low candlepower, located on wharves or on timber structures, which are liable to destruction by ice in the winter. Jones Point Light Station is of little use on account of changes in shore line at this point. It is proposed to establish nine lights, nine fog signals, move one light, change two fog signals from bells to horns, change two spar buoys to tall-type cans, replace one spar buoy with a bell buoy, establish a gas buoy and convert seven oil gas buoys to acetylene gas buoys. Jones Point Light Station and the five minor lights above mentioned may then be discontinued. Detailed estimate:

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|---|---|
| Site for 1 light station, 3 acres, at $333.33 | $1,000 |
| 1 dwelling, 30 by 40 feet, frame, 14,286 cubic feet, at $0.35 per cubic foot | 5,000 |
| 6 light towers, frame, 20 feet high, 6,000 cubic feet, at $0.30 per cubic foot | 1,800 |
| 1 light tower, iron pipe, 25 feet high | 710 |
| 2 fog-signal houses, 15 by 20 by 8 feet, brick, 4,800 cubic feet at $0.50 per cubic foot | 2,400 |
| 6 fog-signal houses, at $100 each | 600 |
| 1 fog-signal tower, 2,000 cubic feet, at $0.30 per cubic foot | 600 |
| Illuminating apparatus for 9 stations | 4,750 |
| Fog-signal apparatus for 11 stations | 14,600 |
| Transfer of one tower | 100 |
| Two light stations on caissons, cast iron filled with concrete: | |
| Steel-sheet submarine stations, 26,000 pounds at $0.25 per pound | 6,500 |
| Cast-iron submarine stations, 25,000 pounds at $0.15 per pound | 3,750 |
| Concrete submarine stations, 260 cubic yards at $35 per cubic yard | 9,100 |
| Piling, staging, erecting | 5,300 |
| Towers, hardware, etc | 850 |
| Riprap, 1,000 tons at $15 per ton | 15,000 |
| Buoys, 2 tall cans, at 500 each | 1,000 |
| Buoy, one gas | 4,000 |
| Buoy, one bell | 1,200 |
| Buoys, converting 7 oil gas to acetylene | 13,837 |
| Chain, sinkers, shackles, and swivels for buoys | 2,903 |
| Total | 95,000 |

No. 8. *Depot for eighth lighthouse district.*—Constructing and equipping a lighthouse depot for the eighth lighthouse district, at New Orleans, La., or vicinity, $132,750.

NOTE.—The act of June 20, 1918 (40 Stat., 608), authorized this work in the sum of $88,500, but no appropriation was made therefor. A lighthouse depot at New Orleans, La., is of great importance for the convenient and economical administration of the district. It should be at district headquarters, where supplies and materials are readily available and where shipments by rail and steamer could be received and accumulated for distribution by tender or other means at the proper time. The lamp shop should be located at this depot, as at present all intercourse with the mechanician in charge is by mail and telegraph, which is an inefficient method and the cause of numerous delays, and the present quarters are crowded, inadequate, and badly located. The stock and stores, excluding buoys and appendages, should be under the eye of the superintendent at all times. The present depot at Port Eads, La., at the South Pass of the Mississippi River, is nearly 100 miles from district headquarters. A desirable site has been secured for the proposed depot, through a permit from the Treasury Department to use a portion of the river frontage outside of the levee at the Marine Hospital, New Orleans, La. The great and continuing increase in the cost of labor and materials necessitates an increase over the original estimate for this project, which was submitted in 1917. Detailed estimate:

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|---|---|
| Wharves on creosoted piles and stringers at $1.50 per square foot (60,000 square feet) | $90,000 |
| Steel shed on wharf at $1.50 per square foot (18,000 square feet) | 27,000 |
| Lamp shop, blacksmith shop, oil house at 52½ cents per cubic foot (30,000 cubic feet) | 15,750 |
| | 132,750 |

No. 9. *Charleston, S. C., lighthouse depot.*—Completing the lighthouse depot at Charleston, S. C., in the sixth lighthouse district, $60,000.

NOTE.—The act of October 22, 1913 (38 Stat., 244), appropriated $125,000 toward the purchase of a site and construction of a wharf and buildings and equipment, so far as funds might permit for a depot for the sixth district. This entire appropriation has been expended, but all the necessary facilities have not been provided. The site itself cost $60,000 and the wharf $46,418. Further requirements to complete the depot include dwellings for keeper and assistant keeper, who are required to live on the reservation, additional filling, water and sewer systems, walks, roads, oil house, additional equipment, etc. A considerable portion of the grounds is now below or only slightly above high tide and should be filled to make it available for use. The wharf is overcrowded with spare buoys and buoys brought in for repairs. It is necessary for a portion of the ground adjacent to the wharf to be surfaced with concrete to provide a suitable storage space for these buoys. Without the completion of this project the district organization is inadequately equipped to efficiently perform its duties. Detailed estimate:

| | |
|---|---|
| Two keepers' dwellings, brick or tile, at 30 cents per cubic foot (20,000 cubic feet each) | $12,000 |
| Oil house: | |
| Concrete pile foundation at $125 each (8 piles) | 1,000 |
| Concrete platform at side at $3 per square yard (624 square yards) | 1,872 |
| Oil house proper (reinforced concrete) at 46 cents per cubic foot (10,700 cubic feet) | 4,928 |
| Concreted area for storage of buoys and chain at 35 cents per square foot (16,000 square feet) | 5,600 |
| Hard-surface roads at $3.50 per square yard (1,600 square yards) | 5,600 |
| Cement walks at 35 cents per square foot (6,000 square feet) | 2,100 |
| Filling and grading at $2 per cubic yard (4,000 cubic yards) | 8,000 |
| Water pipe, installed at $1 per foot (400 feet) | 400 |
| Sewer pipe and drains, installed at $1.20 per foot (1,000 feet) | 1,200 |
| Brick and iron fence on pile foundation, extension of, 40 feet at $20 per foot | 800 |
| One 20-ton traveling crane | 5,000 |
| One 20-ton platform scale in place | 1,500 |
| Fire protection—automatic sprinkler system for storehouse at $1.50 per linear foot (2,000 linear feet) | 3,000 |
| Additional equipment for machine shop, blacksmith shop, and carpenter shop | 2,000 |
| Contingent | 5,000 |
| | 60,000 |

No. 10. *Depot for seventh lighthouse district.*—Purchasing site for and constructing and equipping a lighthouse depot for the seventh lighthouse district, $250,000.

NOTE.—The Lighthouse Service storehouse, wooden smithy, and wharf are on property belonging to the Treasury Department, which is situated in the midst of the United States naval station. The wooden storehouse and wharf, which are highly inflammable, are located between the Navy coal sheds and piers A and B, one of each on each side and are, therefore, in an unusually dirty location. The coal dust is practically always in motion, and when the coal conveyors are in operation it blows about in clouds. It finds its way into the depot keeper's quarters and into the storehouse, where thousands of dollars' worth of property is stored, which it is impossible to keep clean. These coal sheds have been erected since the storehouse was built. Furthermore, there are frequently several Navy torpedo-boat destroyers lying alongside at the Navy piers on each side of the depot wharf, which, in addition to causing a great deal of dirt, are a menace to the lighthouse tenders on account of collision. A new site and wharf are now urgently needed for the efficient and economical work of the district. Detailed estimate:

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|---|---|
| Site, waterfront property, about 100,000 square feet, at $1.25 per square foot | $125,000 |
| Wharf, at $2.15 per square foot (30 by 400 feet) | 25,800 |
| Bulkheading, at $30 per linear foot (400 by 27 by 1 foot) | 12,000 |
| Service building, at 44 cents per cubic foot (70,000 cubic feet) | 30,800 |
| Keeper's dwelling, at 37 cents per cubic foot (24,000 cubic feet) | 8,880 |
| Storehouse, at 18 cents per cubic foot (144,000 cubic feet) | 25,920 |
| Oilhouse, at 28 cents per cubic foot (8,000 cubic feet) | 2,240 |
| Machine shop, at 19 cents per cubic foot (12,000 cubic feet) | 2,280 |
| Carpenter's shop, at 19 cents per cubic foot (12,000 cubic feet) | 2,280 |
| Blacksmith shop, at 19 cents per cubic foot (12,000 cubic feet) | 2,280 |
| Track on wharf, at $1.80 per linear foot (2,400 linear feet) | 4,320 |
| Buoy skids and chain platform, at $1.50 per square foot (25 by 40 feet) | 1,500 |
| Boundary fence, at $3.50 per linear foot (680 linear feet) | 2,380 |
| Water pipe (excavating, furnishing, laying, and covering), at $1.55 per linear foot (280 linear feet) | 434 |
| Shop equipment | 3,886 |
| Total | 250,000 |

No. 11. *Conneaut Harbor, Ohio, aids to navigation.*—Completing the light and fog signal at Conneaut Harbor, Ohio, $19,600.

NOTE.—The act of July 1, 1916 (39 Stat., 317), appropriated $63,500 for a light and fog signal and improving the existing aids in Conneaut Harbor. Owing to the increased cost of labor and material caused by war conditions it is impracticable to complete the station within the amount of the appropriation. Additional funds are required to complete the superstructure of the station, including interior finishing, and to purchase and install the requisite illuminating and fog signal apparatus. Conneaut is an important ore and railroad port, 3,000 vessels a year entering and departing, with total tonnage of approximately 9,000,000. There is an all-year ferry trade out of this port across the lake to Port Stanley, Ontario, for which the present fogbell is an inadequate signal. This project is considered urgently necessary for the immediate needs of the Lighthouse Service, and to complete it $19,600 will be required. Detailed estimate:

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|---|---|
| Plastering | $750 |
| Tile flooring and base | 1,500 |
| Carpentry | 1,125 |
| Plumbing and drainage | 575 |
| Painting | 950 |
| Illuminating apparatus | 2,200 |
| Fog-signal apparatus | 12,500 |
| Total | 19,600 |

No. 12. *Ludington, Mich., aids to navigation.*—Improving aids to navigation and establishing new aids at Ludington, Mich., $75,000.

NOTE.—The present location of the fog-signal station on the end of south pier is 1,500 feet inside of entrance to outer harbor. At present the actual entrance between the breakwaters must be found by feeling around in the fog. This subjects vessels to danger of striking the breakwater. The commerce of Ludington, which includes important car-ferry lines across Lake Michigan, is as important as any other port on the east shore of Lake Michigan, and as this port is most inadequately lighted now this improvement is considered well warranted. It is proposed to establish a main light on the outer end of the north breakwater, with fog-signal apparatus, consisting of electrically-driven air compressor and compressed-air fog signal with oil-engine reserve drive, and to discontinue the present steam fog signal in old wooden structure. Quarters for keepers are to be erected adjacent to the light, as it is unsafe to cross the harbor during the winter and when the ice is constantly broken up by car ferries. The present dangerous condition should be corrected as early as practicable. Detailed estimate:

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|---|---|
| North Breakwater (main light): | |
| Reinforced-concrete foundation, approximately 24 by 24 feet by 20 inches high, 427 cubic yards, at $30 per cubic yard | $12,810 |
| Steel tower, concrete lined, base 15 feet square, top 10 feet square, 40 feet high, 6,480 cubic feet, at $1.25 per cubic foot | 8,100 |
| Cast-iron lantern house, 4th order | 1,900 |
| Fog-signal house, brick and tile, 18 by 33 by 14 feet, 8,500 cubic feet, at 60 cents per cubic foot | 5,100 |
| Foundation for fog-signal house, 60 cubic yards concrete, at $12 per cubic yard | 720 |
| Fog-signal apparatus | 17,770 |
| Illuminating apparatus— | |
| Fourth-order lens with electric light | 2,500 |
| Total for north breakwater | 48,900 |
| South pier— | |
| Concrete foundation | 600 |
| 31-foot steel tower | 400 |
| Total for south pier | 1,000 |

North Breakwater (main light)—Continued.

| | |
|---|---|
| North pier— | |
| Concrete foundation, 30 cubic yards, at $20 per cubic yard | $600 |
| 31-foot skeleton steel tower | 1,200 |
| 300-millimeter lens lantern and electric light | 300 |
| 1,000-foot electric transmission pole line | 500 |
| Total for north pier | 2,600 |
| Keepers' dwelling— | |
| New lot | 500 |
| Three-family house, tile and concrete, 45 by 40 by 30 feet, 54,000 feet, at 36 cents per cubic foot | 19,500 |
| Outbuildings | 1,000 |
| Sidewalks, grading, fences, shore, protection, etc | 1,500 |
| Total for keeper's dwelling | 22,500 |
| Grand total | 75,000 |

No. 13. *Tampa Bay, Fla., aids to navigation.*—Establishing and improving aids to navigation in Tampa Bay, Fla., $17,500.

NOTE.—Tampa is an important seaport with a large and growing commerce by sea. Owing to shallow water in Tampa Bay, deep-draft vessels can reach the city from the Gulf only by means of several comparatively narrow dredged cuts. Provision has already been made for lighting all of the important cuts excepting Cut D, for which lights should be provided as soon as practicable, as large vessels must pass through this cut in order to reach Port Tampa. Detailed estimate:

| | |
|---|---|
| Tower, structural steel, at 19 cents per pound (32,100 pounds), and cast iron, at 8.8 cents per pound (41,860 pounds) | $9,800 |
| Reinforced-concrete piling, in place, at $15.20 per cubic foot (125 cubic feet) | 1,900 |
| Illuminating apparatus (including installation) | 5,800 |
| Total | 17,500 |

No. 14. *Delaware Bay Entrance, aids to navigation.*—Improving the aids to navigation at the entrance to Delaware Bay, $148,500.

NOTE.—In consequence of the continued erosion of the shore line in the vicinity of Cape Henlopen Light, Del., the early destruction of that light unless removed is anticipated, measures taken for the preservation of the shore line having proved unavailing. Every purpose now served by Cape Henlopen Light would be better served by the rebuilding of Harbor of Refuge Light to a height of about 140 feet, as here proposed. The establishment of large gas buoys is also required, one midway between, and in the line connecting Five Fathom Bank Light Vessel and Overfalls Light Vessel, one at the extreme lower and outer end of Hen and Chickens Shoal, and one in approximately the present position of Fifteen Foot Shoal Buoy. With the improvements recommended herein, including a red sector in the new Harbor of Refuge Light to cover Brown Shoal, the ultimate fate of Cape Henlopen Light will have no bearing on the practical needs of navigation in this vicinity. Detailed estimate:

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|---|---|
| Rebuilding Harbor of Refuge tower, reinforced concrete, including living quarters, at $2.70 per cubic foot (45,000 cubic feet) | $121,500 |
| 4 gas and bell buoys, at $4,000 each | 16,000 |
| 2 extra 375-millimeter lanterns, at $1,000 each | 2,000 |
| 2 extra gas tanks, at $600 each | 1,200 |
| Sinkers and moorings for buoys, 4 at $375 each | 1,500 |
| Illuminating apparatus in tower | 3,500 |
| Fog-signal apparatus | 1,300 |
| Boats | 1,500 |
| Total | 148,500 |

No. 15. *Newport, R. I., lighthouse depot.*—Purchasing site and building wharf and storehouse for new lighthouse depot in Narragansett Bay, same to be located at Newport, R. I., or vicinity, $82,300.

NOTE.—The present depot is located on the breakwater at Newport Harbor, which location is very unsatisfactory and inconvenient, as the water at the dock is too shoal for the larger tenders, and there are no facilities for tenders getting water, or having provisions, ice, etc., delivered, which necessitates the tenders going to Newport for provisions, etc., causing much waste of working hours. The Navy Department is building along the breakwater continuously and the present plans of the Navy bring them down to the lighthouse depot. The present dock is in very bad condition, due to age, decay, and worming of piles, and at present is unsafe for further use. Improvement of the depot on the existing site is not considered economical, owing to lack of space and other conditions. Detailed estimate:

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|---|---|
| Site for new depot | $40,000 |
| Piling, 300 piles, at $80 each | 24,000 |
| Concrete dock, 350 cubic yards, at $30 per cubic yard | 10,500 |
| 200,00 feet timber, at $165 per 1,000 board feet | 3,300 |
| Storehouse, 15,000 cubic feet, at 30 cents per cubic foot | 4,500 |
| Total | 82,300 |

No. 16. *California and Nevada aids to navigation.*—Establishing aids to navigation, California and Nevada, $44,750.

NOTE.—Numerous petitions have been received for lighting the channel between Point San Mateo and the mouth of Alviso Slough, San Francisco Bay. This waterway is the natural outlet for nearly all the produce of the extensive Santa Clara Valley, and the annual traffic has been greatly increased on account of the greatly increased demand for this produce. The present channel is narrow and winding and there are no aids to assist mariners in keeping off the shoals at night. Accidents and strandings are of frequent occurrence. Much of the traffic must be carried on at night to take advantage of the tides. Additional lights are urgently needed and should be established at once. Gas buoys should also be provided at Fort Rose and Point Buchan, on the coast of California; these are necessary for the protection of coastwise shipping. There is an urgent demand for a more suitable lighted buoy at Crescent City, Calif.; during the past year one vessel was lost and another damaged at this entrance. There is a heavy traffic in the north channel of Suisun Bay, and two additional lights and echo boards are necessary. The act of August 28, 1916 (39 Stat., 538), authorized aids to navigation on Lake Tahoe, Calif. and Nev., but no appropriation was made therefor, and funds have not been available to properly light the lake, on which are now many power boats. Lake Tahoe has an area of approximately 200 square miles, is 21 miles long, has a mail route 70 miles long, and a great many pasengers are carried there annually on numerous steamers and launches. Detailed estimate:

| | |
|---|---|
| San Francisco Bay, Alviso Channel: | |
| Acetylene-lighted beacons, 3 at $1,500 each | $4,500 |
| Acetylene-gas buoy, type "L" | 4,000 |
| Coast of California, gas and whistle buoys at Point Buchan and Fort Rose, 2 at $5,000 each | 10,000 |
| Gas and bell buoy at Crescent City | 4,500 |
| Spare buoys, one gas and bell, type "L" | 4,000 |
| 3 gas buoys, type "S" at $1,500 each | 4,500 |
| Suisun Bay, 2 lights and echo boards, at $1,250 each | 2,500 |
| Lake Tahoe, 4 gas buoys, type "S," at $1,500 each | 6,000 |
| Lamp houses and lanterns, 3 at $1,250 each | 3,750 |
| Daymarks, single pile, 5 at $100 each | 500 |
| Transportation and subsistence | 500 |
| Total | 44,750 |

No. 17. *Depot keepers' dwellings.*—Construction of two dwellings at the Goat Island Lighthouse Depot, Calif., $18,000.

Note.—The present quarters at the Goat Island Lighthouse Depot, consisting of two old frame cottages located at the water's edge, are wholly inadequate to accommodate the depot force. There are no quarters available for the assistant depot keeper, mechanician, and skilled laborer, all of whom are required to make long journeys to and from San Francisco each day. On account of the position of Goat Island in the middle of San Francisco Bay, with no ferry accommodations except such as can be obtained by means of the Naval Training Station boats, it is essential that all employees at the depot should be housed on the lighthouse reservation, as they are unable to properly carry on their work under present conditions. Orders have recently been issued by the Navy Department to remove the Naval Training Station from Goat Island on account of inclement weather conditions, and it is probable that the present launch service to the island will be very seriously reduced in the near future with great detriment to the Lighthouse Service. Two dwellings are urgently required to be built on the high ground adjacent to the depot for the accommodation of the keeper and the mechanician in charge of the depot shops. Detailed estimate:

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|---|---|
| Two dwellings for keepers, at $0.275 per cubic foot (65,455 cubic feet) | $18,000 |

No. 18. *Cape Spencer (Alaska) Light Station.*—Establishing a light and fog-signal station at or near Cape Spencer, Alaska, $150,000.

Note.—Cape Spencer is at the entrance to Cross Sound and Icy Strait, through which pass all vessels running from Puget Sound ports to Prince William Sound, Seward, Cook Inlet, and Kodiak, excepting only occasional freighters proceeding by outside route. Traffic by way of Cape Spencer is materially increasing owing to construction work on the Government railroad and the consequent development of western and southwestern Alaska. A small unwatched light is now maintained on the cape, but a more powerful watched light and a fog signal of the first class should be provided. A landfall must be made in this vicinity by all vessels returning from the westward, and as the entrance to Cross Sound is difficult to make, especially in thick weather, it is important they be given all the assistance possible. Maritime interests are urging the establishment of this aid. Detailed estimate:

| | |
|---|---|
| Construction plant, including wharf and storehouse | $14,400 |
| Transportation of men and materials | 13,000 |
| Tower, including fog signal and living quarters, at $1.12 per cubic foot (65,000 cubic feet) | 72,800 |
| Lantern, watch room, and other metal work, at 22 cents per pound (83,500 pounds) | 18,400 |
| Boat house, at 25 cents per cubic foot (9,600 cubic feet) | 2,400 |
| Hoist houses, hoists, and derrick | 8,500 |
| Illuminating apparatus | 11,000 |
| Fog-signal apparatus | 9,500 |
| Total | 150,000 |

No. 19. *Galveston Jetty (Tex.) Light Station.*—Improving Galveston Jetty Light Station, Tex., $6,500.

Note.—The original appropriations, June 11, 1896 (29 Stat., 417), and May 27, 1908 (35 Stat., 332) for this station are insufficient for the purchase and installation of a sufficiently powerful fog signal. The commerce of the port of Galveston has been steadily increasing, consisting especially of shipments of cotton, grain, flour, lumber, steel, and canned goods. For the first five months of the calendar year 1919 the value of foreign exports from this port, exclusive of shipments in bond and the coastwise trade, was $131,997,109, and imports, $7,137,929. Four million four hundred and ninety-nine thousand eight hundred and sixty-nine tons of freight were handled at this port in the year 1918, and an adequate fog signal is required to enable vessels to enter Galveston entrance during foggy weather. A fog signal has been urgently requested by the Galveston Commercial Association. It is recommended that a compressed-air fog signal be installed as soon as funds permit. Detailed estimate:

| | |
|---|---|
| Fog-signal apparatus, in duplicate | $5,000 |
| Piping, valves, shafts, foundations, etc | 800 |
| Installation | 600 |
| Incidentals | 100 |
| Total | 6,500 |

No. 20. *Additional buoys, fifth lighthouse district.*—Establishing additional buoys in Chesapeake Bay and York River, Va., for use of Atlantic Fleet, $44,600.

Note.—There were established during the war a considerable number of additional buoys, including many gas buoys, for the use of the Atlantic Fleet in marking approaches to bases and drill grounds in the lower Chesapeake Bay and York River. It was possible to establish and maintain these buoys during the war emergency only by using buoys normally and properly held in reserve for relief purposes, the marking of wrecks, etc., and temporarily discontinuing certain gas buoys in other localities. The reestablishment and maintenance of these aids has been requested by the Navy Department. Detailed estimate:

| | |
|---|---|
| 10 type "L" gas and bell buoys, at $3,481.70 each | $34,817 |
| 1 main channel bell buoy | 950 |
| 1 type "BW" 600-11 gas and whistling buoy | 5,013 |
| Chain, sinkers, and shackles | 3,820 |
| Total | 44,600 |

No. 21. *Staten Island, N. Y., lighthouse depot.*—Improving and extending the wharves at the general lighthouse depot, Tompkinsville, Staten Island, N. Y., $65,000.

NOTE.—The act of June 20, 1918 (40 Stat., 607), authorized the work of improving and extending the wharves at the general lighthouse depot, but no appropriation was made therefor. A portion of the wharves at the general lighthouse depot are in a poor condition and need repairs. The appropriation of $60,000 made by the act of March 28, 1918 (40 Stat., 496), for repairing the wharves, has enabled the Lighthouse Service to accomplish the retopping of the inner south wharf and the inner north wharf, but the increase in cost has made it impracticable to complete the entire repairs needed. Improvements to the south extension of the north wharf, the bulkhead wharf, and the north end of the bulkhead yet remain to be done and are urgently needed, as these sections are in poor condition and hardly serviceable. Temporary repairs to these wharves would be expensive and wasteful. The authorized amount is not sufficient to provide for the extension of the wharves originally proposed, and this may be deferred. The present wharf space is limited and the wharves should be extended. There are 21 vessels in the third district (7 tenders and 14 light vessels) which use the general depot wharves, besides a considerable use by vessels of the Navy Department and commercial ships. Detailed estimate:

| | |
|---|---|
| 14,000 square feet of new top, at $2.15 per square foot | $30,000 |
| 10,000 square feet of top renewed, at $3.50 per square foot | 35,000 |
| Total | 65,000 |

No. 22. *Detroit, Mich., lighthouse depot.*—For completing the improvements to the Detroit lighthouse depot, Mich., $50,000.

NOTE.—The act of July 1, 1918 (40 Stat., 686), appropriated $53,000 for improvements at the Detroit lighthouse depot, but, on account of the great advance in the cost of labor and materials, it is impracticable to complete the work estimated for within the amount appropriated. It is estimated that $34,500 additional is required to complete this work. The only work thus far accomplished is the construction of the outer section of the wharf, which is now in progress, but beyond the completion of this piece of work, it will not be practicable to proceed further with the project without additional appropriation. Further improvements at the depot have since been found necessary which it is desirable and economical to have done as a part of the work already authorized. These consist of the construction of a retaining wall along Mount Elliott Avenue adjoining the lighthouse depot, and the purchase and installation of mechanical equipment in the proposed lamp shop. The latter will enable the Service to make repairs to illuminating and fog-signal apparatus and repairs to vessels during the closed season of navigation, at a considerable saving over the cost in commercial shops. Detailed estimate:

| | |
|---|---|
| Wharf, 19,900 square feet, at $3.30 | $65,670 |
| Dredging, 3,400 cubic yards, at $1 | 3,400 |
| Mooring bullards, 9, at $60 | 540 |
| Steel track, 600 linear feet, at $1.50 | 900 |
| Water supply, electric works, etc | 490 |
| Lamp shop, 27,000 cubic feet, at $50 | 13,500 |
| Retaining wall, 500 linear feet, at $10 | 5,000 |
| Machinery and equipment | 8,000 |
| Contingencies | 5,500 |
| Total | 103,000 |
| Less appropriation made by act of July 1, 1918 | 53,000 |
| Amount required | 50,000 |

Total group No. 1, authorized by law $1,423,000; not authorized $6,566,500. Total $7,989,500.

## GROUP NO. 2.

Works considered essential for the needs of navigation and the equipment of the Lighthouse Service, and which it is recommended be undertaken as resources permit, are submitted with estimates of cost. (These items have been selected from a much larger number of recommendations submitted by the superintendents of the lighthouse districts and others.)

No. 23. *Point Pinos (Calif.) Light Station.*—Improving Point Pinos Light Station, Calif., $40,000.

NOTE.—Traffic to the port of Monterey just inside of Point Pinos is steadily increasing, and the port is now one of the leading points for the shipment of crude oil on the coast. This port also has the most important fishing industry on the coast of California, and several thousand large power fishing boats make their headquarters here. Numerous requests have been received from shipping interests and from fishermen's unions to establish a first-class fog signal at this point. The Union Oil Co. has lost one steamer at the entrance to the harbor, and, as there is an average of 800 hours of fog per annum, the protection asked for is urgently required. In addition to a fog-signal building a dwelling for two keepers is required. Detailed estimate:

| | |
|---|---|
| Fog-signal building | $5,015 |
| Fog-signal apparatus | 11,500 |
| Dwelling for two keepers | 17,985 |
| Improvements to present station | 5,500 |
| Total | 40,000 |

No. 24. *Woods Hole, Mass., lighthouse depot.*—Dredging off a point to give entrance to Little Harbor, Woods Hole Depot, Mass., $15,000.

NOTE.—Owing to the excessive current at the outer shoal, the bar through which the channel was dredged in 1917 has again filled in, and it is believed that it is impracticable to maintain a channel through this bar owing to the excessive current. By cutting off the point referred to and following the natural course of the channel, it is believed that no difficulty from filling in will be experienced at this point in the future. This work to be done by contract, as it can be done more efficiently and economically by this method. Detailed estimate:

| | |
|---|---|
| Dredging, 30,000 cubic yards, at $0.50 per cubic yard | $15,000 |

No. 25. *Michigan Island (Wis.) Light Station.*—Establishing and improving aids to navigation at or near Michigan Island, Lake Superior, Wis., $85,000.

NOTE.—The act approved May 27, 1908 (35 Stat., 332), appropriated $2,000 to make a survey and estimate of cost and report upon the feasibility and need of establishing a light and fog signal upon Gull Island or the easterly end of Michigan Island, Apostle Group. As a result of this survey, the conclusion has been reached that the eastern end of Michigan Island is the better site. The act of June 17, 1910 (36 Stat., 536), authorized the construction of a light and fog-signal station at Michigan and Gull Islands at a cost not to exceed $140,000, but no appropriation has been made therefor. A further study indicates that the best plan is to elevate the present light near the westerly end of Michigan Island, add a fog signal, and establish a nonattended acetylene light on Gull Island. This arrangement would serve as a better guide to vessels passing in either direction. The project now contemplated will not cost as much as the amount authorized. Detailed estimate:

| | |
|---|---|
| Foundation, main light | $3,000 |
| Dwellings for three keepers | 20,000 |
| Tower complete (erection only) | 6,000 |
| Minor light | 9,495 |
| Illuminating apparatus | 10,000 |
| Fog signal and hoisting apparatus | 13,550 |
| Fog-signal building, boathouse, and other buildings | 13,455 |
| Boats, tramway, walks, etc | 9,500 |
| Total | 85,000 |

No. 26. *Kauhola Point (Hawaii) Light Station.*—Improving the light station at Kauhola Point, Hawaii, $20,000.

NOTE.—Owing to the importance of this station, located near the northern point of the Island of Hawaii, steps have been taken to change the present lens-lantern light to a converted flashing fourth-order lens. To support this lantern and lens and to complete the improvement of this station, a new tower is necessary. A dwelling for the assistant keeper should also be provided. Detailed estimate:

| | |
|---|---|
| Reinforced-concrete tower in place, 72 ft. high | $15,750 |
| Dwelling, frame | 4,000 |
| Improvement to grounds | 250 |
| Total | 20,000 |

No. 27. *Santa Barbara (Calif.) Light Station.*—Improving Santa Barbara Light Station, Calif., $40,000.

NOTE.—The station is old and the tower is too small to accommodate the revolving lens now installed in it. The tower stands one-eighth of a mile back from the point of the shore line and the light is partly obscured by trees on other properties. A new tower is required to be built farther out on the point. Coasting vessels bound north keep close inshore to avoid the prevailing northwesterly winds and sea, and a fog signal should be established here with quarters for two additional keepers. At present there are no fog signals between Point Hueneme and Point Conception, and there is a very heavy traffic through this part of the Santa Barbara Channel, and as several strandings have already occurred in the vicinity of the light station, there is urgent need for this improvement. A fog signal and a new light tower, together with suitable quarters for an additional keeper are required. Detailed estimate:

| | |
|---|---|
| Tower, lantern, and fog-signal building | $15,500 |
| Fog-signal apparatus | 11,500 |
| Additional quarters | 9,520 |
| Improvements to present station | 3,480 |
| Total | 40,000 |

No. 28. *Portage Lake, Mich., aids to navigation.*—Establishing a light and fog-signal station upon a new site and improving aids to navigation at Portage Lake Ship Canals, Mich., $100,000.

NOTE.—The War Department intends to remove the breakwater, and it is therefore necessary to rebuild the light and fog signal on a new site. The new light and fog signal should be established on a pier of the outer entrance, where it would be of the best service to vessels making the harbor. The construction of the station proposed will require considerable time to complete, and this project should have consideration for that reason. The harbor pier on which the present pierhead light station and fog-signal house stand, as well as the timber superstructure under the fog-signal house, are rapidly deteriorating, and it is doubtful if these structures can be maintained much longer in a safe condition unless extensive repairs are made to their foundations, which would be unnecessary in the event of the establishment of the proposed new station. Detailed estimate:

| | |
|---|---|
| Foundation and concrete base of tower | $64,000 |
| Superstructure | 22,500 |
| Fog signal and lighting equipment | 13,500 |
| Total | 100,000 |

No. 29. *Ram Island (Me.) Light.*—Establishing a light on Ram Island, lower Kennebec River, $5,400.

NOTE.—The need of this light has several times been expressed by petition. Ram Island is about 5½ miles below Bath, Me.; it is a low island in the middle of the river, with a string of half-tide ledges making off on the easterly side. There is a passage on either side, and at some stages of the tide a 5-knot current exists, from which several accidents have occurred. About 420,000 tons of freight and 175;000 passengers are transported past this island annually, not including the many pleasure craft and small boats which frequent the river. It is proposed to establish an acetylene light on or near the easterly side of Ram Island. Detailed estimate:

| | |
|---|---|
| Light structure, including site | $3,050 |
| Illuminating apparatus and installation | 1,950 |
| Contingencies | 400 |
| Total | 5,400 |

No. 30. *Cape Kumukahi (Hawaii) Light.*—Establishing a light at or near Cape Kumukahi, Hawaii, $22,000.

NOTE.—Cape Kumukahi is the easternmost cape of Hawaii. There is at present no landfall light for vessels bound to Hilo from the Panama Canal or from the southeast. It is a difficult point to round when sailing from Hilo to the south point or vice versa. A light on this point would be a great improvement to the lighting of the islands. An acetylene light is recommended, with a focal-plane height of about 145 feet above the sea, which would be visible about 20 miles. Landing from seaward at the cape is impossible at most times, and the only practical method of supplying this station would be by railroad from Hilo to Kapoho and then by wagon road 3 miles to the cape, 1½ miles of which would have to be constructed over the rock. Detailed estimates:

| | |
|---|---|
| Station site and right of way for road | $500 |
| Concrete foundation for tower | 740 |
| Superstructure, iron-pipe tower | 9,000 |
| Illuminating apparatus | 4,640 |
| Roadway, construction of | 7,120 |
| Total | 22,000 |

No. 31. ***Henderson Point (Me.) Light Station.*—Establishing a light and fog signal at or near Henderson Point, Piscataqua River, Portsmouth Harbor, Me., $7,500.**

NOTE.—The need of this aid has several times been expressed by petition. It is often very difficult to ocate Henderson Point at night and in thick weather; the channel is narrow and there is a strong tide at this point, where the course changes. The commercial statistics for Portsmouth Harbor indicate about 5,600 vessels arriving and departing annually, transporting about 610,000 tons of freight. It is proposed to establish an acetylene light with fog bell. Detailed estimate:

| | |
|---|---|
| Structure, including site | $3,350 |
| Illuminating and fog-signal apparatus | 3,750 |
| Contingencies | 400 |
| Total | 7,500 |

No. 32. ***Port Real (P. R., or East Point Vieques Island) Light Station.*—Establishing a light station at or near Port Real, P. R., or East Point Vieques Island, $40,000.**

NOTE.—The lighthouse at Port Ferro, on the south coast of Vieques, or Crab Island, is one of the primary seacoast lights of the Porto Rican system. The light tower and the keepers' dwelling attached to it are built on top of a rocky promontory undermined for some time by the sea, and the whole structure, already dangerously cracked, is in danger of collapsing. It is urgent to rebuild a lighthouse at or near this point, as this is an important aid to the navigation from St. Thomas to Cuba and other West Indian Islands and the Caribbean Sea. A light in this vicinity is necessary for navigation, and it is proposed to dismantle the present Port Ferro Light Station and to erect a new light station at Port Real, about 3 miles westward, where the aid will be more useful and on better ground than on its present location at Port Ferro, as Port Real is the most important and the best anchorage around Vieques Island. The present apparatus at Port Ferro is to be used for this new station. Detailed estimate:

| | |
|---|---|
| Tower | $15,000 |
| Dwelling for 2 keepers | 10,000 |
| Metal work | 8,000 |
| Woodwork | 2,000 |
| Outbuildings and fence | 1,000 |
| Purchase of site | 2,000 |
| Grading and walks | 1,000 |
| Installation of illuminating apparatus | 1,000 |
| Total | 40,000 |

No. 33. *Nine Mile Point (Mich.) Light Station.*—Establishing a light and fog-signal station at or near Nine Mile Point, Mich., $50,000.

NOTE.—When Forty Mile Point Light Station was established it was placed on the site designated Forty Mile Point on the county-survey charts. Sailing masters expected the station to be placed at Nine Mile Point, near the entrance to the Straits of Mackinac, but which was not so called officially then. While Nine Mile Point is within the visibility of Spectacle Reef and Poe Reef Light Vessel lights, a fog signal would be of especially great service in thick and foggy weather and during seasons when forest fires prevail. No less than nine strandings occurred here between 1903 and 1909. In the event of establishing this station, Forty Mile Point could be made a minor light. Detailed estimate:

| | |
|---|---|
| Tower and fog-signal building, including site | $26,100 |
| Illuminating apparatus | 5,500 |
| Fog-signal apparatus | 2,000 |

| | |
|---|---|
| Dwellings for three keepers | $12,000 |
| Outbuildings, boathouse, fences, etc | 2,600 |
| Boats and equipment | 1,800 |
| Total | 50,000 |

No. 34. *Grays Harbor (Wash.) Light Station.*—Improving Grays Harbor Light Station, Wash., $20,000.

NOTE.—The present steam fog-signal plant at this station is located in a frame building. Both the machinery and building are quite old and in poor condition. It is proposed to construct a new fireproof building and install an electrically operated siren as soon as funds permit. Detailed estimate:

| | |
|---|---|
| Fog-signal building | $9,690 |
| Purchase and installation of apparatus | 10,310 |
| Total | 20,000 |

No. 35. *Aids to navigation, Alaska.*—Establishing new aids to navigation and for improvements to existing aids in Alaska, $75,000.

NOTE.—An appropriation of $75,000 was made by the act of July 19, 1919, for aids to navigation in Alaskas but a considerable part of this has already been obligated, and there is a demand from maritime interest, for the further establishment of new aids to facilitate and safeguard water transportation in Alaska, where navigation is unusually difficult and hazardous, as shown by the frequency of marine disasters occurring in these waters. A number of unwatched lights on shore or on reefs, and a number of lighted buoys are needed to mark the principal routes of navigation through inside passages. A few such lights are needed to mark headlands on the outside coast for the benefit of coasting traffic, and there are a number of requests for lights to mark the entrance to harbors where fish packing or other plants are located. The fishing industry in Alaska is now being greatly expanded and many new plants are being constructed in localities not heretofore visited by large steamers. This fact has given rise to a greatly increased demand for new aids. Detailed estimate:

| | |
|---|---|
| 2 gas buoys, at $8,100 each | $16,200 |
| 4 gas buoys, at $5,100 each | 20,400 |
| 3 lights on steel towers, at $4,000 each | 12,000 |
| 6 lights, at $2,000 each | 12,000 |
| 7 lights, at $1,300 each | 9,100 |
| 4 lights, at $800 each | 3,200 |
| Miscellaneous minor aids | 2,100 |
| | 75,000 |

No. 36. *Lake Champlain, N. Y.*—Establishing acetylene lights, building and equipping a gasolene tender, and rebuilding Juniper Island Light Station wharf to accommodate the tender on Lake Champlain, and other improvements to aids to navigation on Lake Champlain, $150,000.

NOTE.—In the interest of efficiency and economy it is proposed to discontinue all oil lights on Lake Champlain except at stations where there is a fog bell, and establish acetylene lights in their places. The motor-driven tender will remain constantly on the lake to care for the operation and repair of the light stations. This change from oil to acetylene will result in considerable saving. It will permit better care and maintenance of the aids to navigation on Lake Champlain and relieve the tender *Daisy* from this work, thus enabling her to do more work in the vicinity of New York Bay, where her services are much needed. Detailed estimate:

| | |
|---|---|
| 8 large lights | $25,000 |
| 21 small lights | 55,000 |
| Gasolene tender | 25,000 |
| Rebuilding wharf at Juniper Island Light Station, with storeroom, gas-tank house, and ways for taking tender out of water in winter | 45,000 |
| Total | 150,000 |

No. 37. *Sag Harbor, N. Y.*—Establishing five acetylene lights in the channel leading into and in the vicinity of Sag Harbor, N. Y., and improving illuminating apparatus at Sag Harbor Breakwater and Cedar Island Light Stations, $45,700.

NOTE.—This channel is crooked, narrow, and rocky, and a system of acetylene flashing lights is much needed. It is proposed to place the lights on steel towers having concrete and riprap foundations. Detailed estimate:

| | |
|---|---|
| 5 acetylene lights complete | $30,600 |
| Improving illuminating apparatus, Sag Harbor Breakwater Light | 6,100 |
| Improving illuminating apparatus, Cedar Island Light | 9,000 |
| Total | 45,700 |

No. 38. *Repairs and improvements, light stations, Alaska.*—Repairs and improvements to existing aids to Alaska, $77,000.

NOTE.—Owing to the increasing volume and importance of the commerce of Alaska, it is very desirable that important improvements be made in certain lights and fog signals, as urged by mariners. Also, it is necessary to replace some worn-out station equipment, and at some stations improvements are needed for the betterment of protection of the station. At Guard Island, an important station at the westerly end of Tongass Narrows, it is desired to replace the present unsatisfactory fog bell with an air diaphone and to construct a suitable permanent light and fog-signal building to replace present temporary wooden tower; also to erect another dwelling in order that two keepers may be assigned instead of one as at present, and thus provide for continuous night and day watches. At Point Retreat, an important station, there is now only an unwatched acetylene light and no fog signal. All regular vessels plying between southeastern and southwestern Alaska pass this point, either by way of Favorite Channel or by way of Lynn Canal and Skagway. It is proposed to establish an air diaphone fog signal and assign keepers, a suitable permanent structure to be erected for the light and fog signal, and unused dwelling now at the station to be repaired and refurnished for the use of the keepers. At Scotch Cap it is proposed to install a flashing lens in place of present fixed lens, which will increase the power of the light and render it distinctive from other fixed lights. This is an important coast station located on Unimak Pass and is made by all vessels passing from the Pacific Ocean to Bering Sea. Shore protection is also needed at this station, as the dwellings are threatened by encroachment of the sea, and new machinery is needed to replace that worn out in service. At Tree Point Light Station present water supply is subject to interruption through freezing and is not considered healthful. It is proposed to lay a pipe line to a lake about 1 mile distant. Mariners have complained that the air siren fog signal at Cape Hinchinbrook Light Station is not effective, and it is desired to replace same with an air diaphone. This is a very important station situated at the entrance to Prince William Sound. Detailed estimate:

| | |
|---|---|
| Guard Island Light Station—Install diaphone, construct light and fog-signal building, erect dwelling, etc | $30,500 |
| Point Retreat Light—Install diaphone, construct light and fog-signal building, repair dwelling, etc. | 31,000 |
| Scotch Cap Light Station—Purchase new compressors and engines, install flashing lens in place of fixed lens, construct shore protection | 10,000 |
| Tree Point Light Station—Construct pipe line from lake to station | 2,000 |
| Cape Hinchinbrook Light Station—Install diaphone in place of present siren | 1,500 |
| Contingencies, repairs, and improvements | 2,000 |
| Total | 77,000 |

No. 39. *Depot for second lighthouse district.*—Completing the construction and equipment of a lighthouse depot for the second lighthouse district, $123,645.

NOTE.—The act of July 1, 1918 (40 Stat., 607), appropriating $85,000 for dredging two slips, building retaining walls to same, rebuilding wharf, building service building and oil house, etc., at Chelsea, Mass., was based upon estimates made in 1911. The great advance in cost of building materials and labor makes the appropriation inadequate for the purpose intended. The present lighthouse depot in the northern end of the second district is located on Lovells Island about 9 miles from Boston, and is on land belonging to the War Department and urgently required by them for war purposes. The transaction of the work in the northern end of second district is greatly handicapped and the duties of the tenders much increased by having the base of supplies located nearly an hour's steaming from Boston. The new depot at Chelsea should be properly equipped and the depot established there at the earliest practicable date. The work of construction to be done by contract, as it can be done more efficiently and economically by this method. Detailed estimate:

| | |
|---|---|
| Dredging | $19,200 |
| Retaining walls | 78,191 |
| Wharf | 15,000 |
| Filling and grading | 6,000 |
| Service building, fireproof, 35 by 80 feet | 45,000 |
| Keeper's dwelling, 25 by 35 feet | 8,750 |
| Oil house, brick, 25 by 40 feet | 3,400 |
| Carpenter shop and storehouse, 30 by 60 feet | 7,200 |
| Buoy cleaning shed, 20 by 50 feet | 4,000 |
| Buoy skids and chain platform | 4,375 |
| Boundary fence | 2,670 |
| Railroad, push cars, motors | 4,600 |
| Electric-welding set and air compressor | 3,200 |
| Water main | 2,500 |
| Machine-shop equipment | 2,075 |
| Contingencies | 2,384 |
| | 208,645 |
| Less amount appropriated by act of July 1, 1918 | 85,000 |
| Total | 123,645 |

No. 40. *Great Salt Pond (R. I.) Light Station.*—Completing light and fog signal on extreme end of breakwater, Great Salt Pond, R. I., $53,000.

NOTE.—An appropriation of $20,000 for this work was made by the act of June 12, 1917 (40 Stat., 161), but on account of increase in cost of labor and material and of changing the location to extreme end of breakwater, with foundation in much deeper water than was previously planned, and in order to make this harbor available for submarines, the funds previously appropriated are insufficient and an additional appropriation is required to complete the work, the original appropriation being only sufficient to construct the foundation in the extra depth of water. Detailed estimate:

| | |
|---|---|
| Tower, dwellings, and engine room on concrete foundation | $36,000 |
| Fog-signal apparatus | 8,500 |
| Illuminating apparatus | 2,100 |
| Installation of fog-signal machinery and illuminating apparatus | 3,100 |
| Oil-storage tanks | 1,300 |
| Incidentals | 2,000 |
| Total | 53,000 |

No. 41. *Inland waterway, Norfolk, Va., to Beaufort Inlet, N. C., aids to navigation.*—Establishing and improving aids to navigation to mark the improved inland waterway from Norfolk, Va., to Pamlico Sound, N. C., $63,000.

NOTE.—The work of the U. S. Engineers on the 12-foot project for inland waterway from Norfolk, Va., to Beaufort Inlet, N. C., has reached a point where it seems certain that an available depth of 12 feet throughout will be available in the early part of 1920. The section from Norfolk, Va., to Albermarle Sound, N. C., is expected to be completed to a 12-foot depth in February, 1920, and pending the completion of the ultimate project via Alligator River and Pungo River it is proposed to dredge a 12-foot channel through Croatan Sound, N. C., and across Bluff Shoal, N. C., in Pamlico Sound, N. C. Traffic through this waterway is now increasing, and recent reports indicate heavy traffic when the channel is completed. There will have been expended on this project at that time approximately $3,400,000, and in order to make the same fully available to the anticipated through traffic, it will be necessary to establish about 29 small acetylene lights, 25 unlighted beacons, 14 spar buoys, and 2 gas and bell buoys. These aids will at the same time replace 14 existing lights of an antiquated and inefficient type and which, having been in service about 30 years, are in need of renewal. Detailed estimate:

| | |
|---|---|
| Pile foundations | $6,885 |
| Rear range towers | 6,250 |
| Illuminating apparatus | 29,805 |
| Unlighted beacons | 3,750 |
| Spar buoys with moorings | 600 |
| Gas and bell buoys, with moorings | 14,400 |
| Fender dolphins, 5 at $262 each | 1,310 |
| Total | 63,000 |

No. 42. *Fairport Harbor, Ohio, aids to navigation.*—Improving the aids to navigation at Fairport Harbor, Ohio, additional to amount appropriated by act of June 12, 1917, $35,500.

NOTE.—The act of June 12, 1917 (40 Stat., 161), appropriated $42,000 for improving aids to navigation at Fairport Harbor, Ohio. This estimate contemplated the construction of a new lighthouse on the west breakwater pierhead and installation of a compressed-air fog-signal. Owing to the increased cost of all materials and labor the appropriation is insufficient to carry out the project. Upon completion of the new structure an additional keeper will be required, making three in all. Quarters are now provided for only one keeper. An item has, therefore, been included in this estimate to cover remodeling the old dwelling and building a new double dwelling, providing quarters for the three keepers. Detailed estimate:

| | |
|---|---|
| Remodeling old dwelling, one keeper | $2,500 |
| New double dwelling, two keepers | 13,500 |
| Concrete foundation | 14,000 |
| Superstructure | 38,000 |
| Illuminating and fog-signal apparatus | 9,500 |
| | 77,500 |
| Less amount appropriated by act of June 12, 1917 | 42,000 |
| Total | 35,500 |

No. 43. *Lansing Shoal (Mich.) Light and Fog-Signal Station.*—Establishing a light and fog-signal station at Lansing Shoal, Mich., $304,000.

NOTE.—This dangerous shoal, which is now marked by a light vessel, is located at the most important point on the northerly passage to and from the Straits of Mackinac. Maritime interests are urgent in their requests for a better light and a more adequate fog-signal, located on a fixed crib. The light vessel is compelled, by reason of ice conditions, to be off her station in the early spring and late fall. The important commerce through this passage, both before the light vessel has been placed on her station and after she is compelled to leave it in late fall, fully warrants that a permanent first-class light and fog signal, rather than a light vessel, be used in this passage. The annual traffic past Lansing Shoal averages not less than 25 to 30 million tons, which reduced to vessel passages on the basis of an average load of 5,000 tons, which is a fair average for traffic on Lake Michigan and Green Bay, would indicate the annual passage of approximately 5,000 vessels in this vicinity. The establishment of this fixed station will permit of the discontinuance of the Squaw Island fog signal and the substitution of an acetylene unattended light for the present Squaw Island Light Station, which will do away with the three keepers and make an annual saving in expense of some $2,300.

A reinforced concrete foundation pier about 70 by 60 feet by 20 feet high, above water, resting on proper underwater substructure and supporting rectangular steel building, surmounted by third-order lantern house; plane to be about 60 feet above water, equipped with third-order lens and high-power fog signal and submarine bell. Detailed estimate:

| | |
|---|---|
| Foundation pier complete | $200,000 |
| Steel building, superstructure with lantern house | 61,000 |
| Boats and boat cranes | 15,000 |
| Fog-signal apparatus | 15,000 |
| Illuminating apparatus | 10,000 |
| Furniture and miscellaneous equipment | 3,000 |
| | 304,000 |

No. 44. *Two Rivers, Wis., pierhead.*—Improving light and fog signal at Two Rivers, Wis., $6,000.

NOTE.—This station is now equipped with an electrically operated fog bell and sixth-order lens illuminated by wick-oil light. For several years past there has been an insistent demand from Two Rivers that the fog signal be improved, owing to the fact that craft operating out of Two Rivers found the bell of little assistance in making the port during fog. As it is necessary to maintain two keepers to operate the bell, the operating expense will be increased but little if an adequate and efficient signal is installed. It is proposed to install a diaphone fog signal and electrically driven compressors (current from city) and provide an oil engine-driven electric generator for emergency use. Also to install electric light in sixth-order lens in place of oil light. Detailed estimate:

| | |
|---|---|
| Repairs to present wooden tower and to frame power house | $700 |
| Fog-signal equipment | 5,200 |
| Illuminating equipment | 100 |
| Total | 6,000 |

Total, group No. 2, $1,377,745 (not included in total of estimates).

# DESCRIPTIONS OF NEW WORKS COMPLETED.

## PROTECTION OF LIGHT STATIONS, CHESAPEAKE BAY AND POTOMAC RIVER.

*Purpose.*—During the winter of 1917–18 ice floes wrought an unprecedented amount of damage to screw-pile lighthouses and light stations in the Chesapeake Bay and the Potomac River. It became necessary to build up existing protection works of riprap stone near to and around these stations and construct new ice barriers or breakers of riprap stone to protect the stations.

*Sites.*—Cedar Point Light Station, Chesapeake Bay, Md., 700 tons of riprap stone were placed on the southeast side of the station along the concrete sea wall to protect same from action of the ice and sea.

Point Lookout Light Station, Potomac River, Md., 700 tons of riprap stone were placed along the shore between high and low water to stop the erosion of the beach and the encroachment of the seas on the buildings of the station.

Ragged Point Light Station, Potomac River, Md., 600 tons of riprap stone were placed to build up a mound to act as an ice breaker for the screw-pile lighthouse.

Blakistone Island Light Station, Potomac River, Md., 400 tons of riprap stone were placed to restore the existing shore protection displaced by ice and storms.

Mathias Point Shoal Light Station, Potomac River, Md., 500 tons of riprap stone were used to construct a new ice breaker and build up an existing ice breaker which was leveled off by the attack of ice floes.

*Cost.*—The act of March 28, 1918, appropriated $100,000 for repairing and rebuilding aids to navigation, Atlantic coast. The placing of riprap stone at the stations mentioned above was one of the projects completed from this appropriation in the fiscal year 1919. The work was started November 10, 1918, and completed April 15, 1919. Total amount expended on this project, $30,066.41.

## REPAIR OF SABINE BANK LIGHT STATION, TEX.

*Purpose.*—The hurricane of August 16–17, 1915, washed the hatches off the main gallery floor about 26 feet 6 inches above mean high water, flooding the cellar. The main gallery roof, the supporting stanchions, and some of the gallery footplates, also the water-closet and landing ladder and hatch on the east side, both boats and one pair of davits, and several plates of the main tower above the gallery roof were carried away. Extensive repairs were required to replace this damage and to make the station proof against similar destructive effects of future storms, so far as possible.

*Work accomplished.*—A cylindrical wall of heavy, flanged, cast-iron plates, approximately 8 feet high, was erected on the main gallery inclosing a space about 5 feet 6 inches wide extending entirely around the tower. Over this a reinforced-concrete roof was placed, supported on steel T's, which also served to anchor the top of the cast-iron plates to the main tower. Openings are provided in the cast-iron plates for 13 air ports and double steel doors. The air ports are provided with plate-glass windows in hinged metal frames 14 inches in diameter. The remaining gallery space, which is about 3 feet wide, is surrounded by a substantial iron railing. Two new sets of boat davits, extending 18 feet above the main gallery floor, have been installed, with operating platforms accessible from the second story of the tower. With these davits the station boats may be landed on the platforms provided above the roof of the main gallery out of reach of storm waves. Other repairs necessary to put the station in first-class condition have been made.

*Cost.*—The cost of this work amounted to $15,047.49 and was paid from special funds provided for repairing and rebuilding aids to navigation, Gulf of Mexico destroyed by hurricane.

## MOVING OF CAPE SAN BLAS LIGHT STATION, FLA.

*Purpose.*—The erosion of the shore well inside of the former location of the tower mdae it necessary to move the 98-foot skeleton iron tower to a site 1,857 feet NNE. ¾ E.

*Site.*—The new site is on the next sand ridge to the westward of the station dwellings, and was selected so that the lantern of the tower would be visible above the trees of the cape in all directions from seaward.

*Work accomplished.*—The light was temporarily discontinued on April 30, 1918, while the tower was being taken down and moved, and was again exhibited in its new location, with focal plane 101 feet above water, on January 22, 1919. An 8-foot walk, with track for flat car, was built from the old to the new site across beach and the inside ravine between ridges, and the sections of the tower were thus expeditiously moved.

*Foundation.*—A new foundation was built, consisting of nine reinforced concrete blocks 9 feet square by 5 feet 6 inches high, each resting on two rows of 12 by 12 inch timber grillage, which was through-bolted to 12 by 12 inch clamps, bolted to four 38-foot round piles. The grillage, clamps, and piles are long-leaf yellow pine creosoted. 16 pounds of creosote oil per cubic foot. Before the piles were driven the ground in the location of each block was sufficiently excavated to permit the preparation of pile heads and bolting of clamps and grillage. The piles are so driven that the elevation of their tops, between second and top rows of grillage, is at mean-low-water level. The water level in each pit was kept low by sheet piling and pumping, so that access to the pile heads could be had. Additional bolts were provided to anchor the concrete blocks to the grillage. These bolts extended 2 feet into the concrete blocks. The concrete blocks were molded as a monolith, with edges beveled.

*Cost.*—The total cost of moving tower to new site, including necessary new walks, etc., was $17,997.67, and was paid from appropriation of $125,000 made by act of September 8, 1916, for repairing or rebuilding aids to navigation damaged or destroyed by hurricane in the Gulf of Mexico.

## AIDS TO NAVIGATION, CARIBBEAN SEA.

*Purpose.*—Upon the joint request of the Secretary of the Navy and the Secretary of Commerce, the President allotted $100,000 from the appropriation for national security and defense for the purpose of establishing lights to mark the reefs which lie in the path of vessels between the Yucatan Passage and the Panama Canal.

*Structures.*—Lights were established and placed in commission in the latter part of June, 1919, on Serrana Bank, Quito Sueno Bank, and Roncador Cay. Each light consists of a 375-millimeter, flashing, acetylene lantern on a 40-foot structural-steel tower. The tower is supported on the top of a steel tank house, having a concrete foundation and providing storage space for the battery of compressed-acetylene tanks which contain a supply of gas sufficient for approximately 12 months' service. Each light is provided with a "sun valve" which automatically cuts off the gas supply during daylight. The effective range of these lights is approximately 12 miles. The erection of these lights was successfully accomplished by a field force from the eighth lighthouse district under the direction of the superintendent on general duty, Lighthouse Service, who was assisted by the officers and crew of the U. S. gunboat *Wheeling*, which vessel carried the party and the materials and equipment from New Orleans to the several locations. The lights being automatic, no keeper is required, but masters of passing vessels have been requested to report their condition as opportunity is presented for observations.

*Cost.*—The total cost of the establishment of these three lights, exclusive of the services rendered by the Navy Department, amounts to $26,163.89.

## AIDS TO NAVIGATION, LORAIN HARBOR, OHIO.

*Purpose.*—Owing to the enlargement of the harbor by the construction of offshore breakwaters, a new light with fog signal was required to mark the entrance to the harbor at the end of the west breakwater. The permanent light was placed in commission April 7, 1919, and the fog signal May 13, 1919.

*Site.*—The station is located at the north end of the west breakwater at the entrance to the harbor.

*Structure.*—The building is a steel frame structure, with concrete walls about 28 feet square, having two stories and attic, erected on the concrete pierhead. The roof is covered with asbestos shingles, and a monitor for housing the fog signal is built on the northwest roof. The tower rises from the southeast corner of the building and is surmounted by a fourth-order, helical-bar lantern. The power-room floor is of concrete and the floors above are of hardwood. A pipe railing extends around the pier for protection.

*Illuminating apparatus.*—This comprises a fourth-order revolving lens having three dioptric panels of fixed type, with three alternate panels of double mirrors, mounted on a mercury float pedestal and using a type "A," 35-millimeter, incandescent oil-vapor outfit. The light characteristic is occulting white every 10 seconds, light 5 seconds, eclipse 5 seconds, with candlepower of 7,300. The focal plane is 58 feet above mean lake level, and the light is visible 15 miles.

*Fog signal.*—The fog signal is a type "C" diaphone, using compressed air. The power plant consists of a 13 horsepower and one 20 horsepower oil engine and compressor unit, operating on kerosene or power distillate. The characteristic is one blast and group of 2 blasts (12) every 30 seconds.

*Quarters.*—There are three keepers who have quarters in the building while on duty. No quarters for families ashore have yet been provided. The basement contains cistern, coal bin, and storage space. The first floor contains the power room, bathroom, and storeroom. The second floor contains a living room, pantry, a bedroom, and a tank room. The third floor is a storeroom containing the diaphones and timing device, water tank, and stairs leading to lantern.

*Cost.*—The act of October 22, 1913, appropriated $35,000 for the work, which was done by hired labor and purchase of materials. Total cost to June 30, 1919, $34,974.54.

## SAND HILLS LIGHT STATION, MICH.

*Purpose.*—The shore line of Lake Superior off Keweenaw Point and abreast of Eagle River, Mich., is fringed with rocky shoals on which a number of vessels have been wrecked. The purpose of this project is to provide an adequate light and fog signal station to mark these reefs.

*Site.*—This station is located about 3¾ miles west of the town of Eagle River, Mich., on "Five Mile Point." The reservation comprises an area of about 47 acres heavily wooded along the rocky shore line, with sand hummocks inland. The land about the station has been cleared to permit an uninterrupted view of the light and station from seaward.

*Structures.*—Structures include a combined tower and triple dwelling, fog-signal house, storehouse, boathouse, oil house, and landing dock, all connected by concrete sidewalks.

The combined tower and dwelling, which is the main structure, is of buff-colored, pressed brick. This building consists of a square tower 70 feet high and three separate apartments, which surround it on the front and two sides. The location is about 150 feet inshore on sand foundation. A steel grillage supports the tower proper, which is of fireproof construction throughout, having steel framing, concrete floors, and steel stairs, doors, window sash, and frames. The cornice and ballustrade are cut stone and the lantern deck cast iron. The lantern is of the 7 foot 1 inch diameter helical bar, revised design. The second story of the tower is used as an office by the keepers and has separate entrances into each apartment. The basement, which is accessible from the cellar of each apartment, contains a central heating plant and control valves for the pneumatic water-supply system.

The apartments, or keepers' quarters, have timber floors, partitions, etc., and are provided with fire walls where they adjoin. The roofing material is of copper. The side apartments have each six rooms and the front five rooms, in addition to bathroom, pantry, and basement. All are supplied with cooking stoves, hot and cold water, modern plumbing, and hot-water heat.

The fog-signal house is of hollow tile, with stucco finish, asbestos shingle roof, and concrete floor. Boathouse and barn are frame and oil house of brick, similar to main structure.

*Illuminating apparatus.*—The illuminating apparatus is a fourth-order, ball-bearing-mounted, flashing lens revolved by a weight-operated clock, producing one flash of 24,000 candlepower every 10 seconds. The light is 91 feet above lake level and is visible approximately 18 miles in clear weather. A type "B," 35-millimeter, incandescent oil-vapor lamp is used.

*Fog signal.*—The fog signal consists of a duplicate installation of type "F" air diaphones and straight-line, direct-connected air compressors and oil engines; blast, 5 seconds every 30 seconds. The timing mechanism is belt-driven from engines. The audibility is approximately 7 miles under favorable conditions. The cast-iron diaphone resonators project through the gable on the north end of the fog-signal building on a line normal to the traffic lane.

*Quarters.*—One keeper and two assistants are quartered in the main building described above.

*Landing dock and grounds.*—A large amount of clearing has been done on the reservation. Sidewalks connect the principal structures and the landing dock, and an industrial track laid for transporting supplies from dock to station buildings. The concrete dock is built along the inside of a reef, where there is from 4 to 6 feet of water, affording good landing facilities for boats delivering supplies. Water for the fog-signal engines is obtained from a well supplied by natural drainage, while water for station use is obtained directly from the lake.

*Cost.*—The act of June 12, 1917, appropriated $70,000 for this project. Amount expended to June 30, 1919, $68,714.69. All work at the station was carried out by hired labor and the purchase of materials, employing the regular district field force. Work was actively commenced in the late fall of 1917; the fog signal was placed in operation on May 15, 1919, and the main light on June 19, 1919.

## AIDS TO NAVIGATION, ALASKA.

*Purpose.*—To meet the demands of the increasing commerce and to continue the work of establishing efficient aids to navigation, eight acetylene lights and one gas and bell buoy were established at various points in Alaskan waters, during the fiscal year ending June 30, 1919. Data relative to these aids are shown in tabular form on the following page.

*Quarters.*—No quarters were provided. All acetylene lights are of the unwatched type, using compressed acetylene in acetone, supplied from batteries of steel cylinders, which contain a sufficient supply of gas to operate the light continuously between visits of lighthouse tenders.

*Cost.*—The amount of $2,618.08 was expended from the appropriation of June 12, 1917, during the fiscal year 1919.

| Name of light. | Locality. | Structure. | Illuminating apparatus. | Characteristic. | Intensity of light in candles. | Focal plane above mean high water in feet. | Miles seen. | Approximate cost. | Date of establishment. |
|---|---|---|---|---|---|---|---|---|---|
| Morris Reef Gas and bell buoy. | Chatham Strait | Black cylindrical superstructure, 200 millimeters. | Acetylene lens lantern. | Flashing white (flash 0.3 sec., eclipse 2.7 sec.). | 130 | 12 | 8 | $3,788.60 | Dec. 3, 1918 |
| Boat Rock | Revillagigedo Channel. | White wooden house on skeleton tower, 200 millimeters. | do | Flashing white (flash 1 sec., eclipse 9 sec.). | 130 | 46 | 9 | 2,304.16 | Sept. 1, 1918 |
| Gravina Point | Prince William Sound. | White wooden house, 200 millimeters. | do | Group flashing white (1st flash 0.3 sec., eclipse 0.9 sec.; 2d flash 0.3 sec., eclipse 4.5 sec.). | 130 | 15 | 9 | 1,919.20 | Sept. 2, 1918 |
| Lemesurier Island | Icy Strait | do | do | Flashing white (flash 1 sec., eclipse 9 sec.). | 130 | 42 | 9 | 1,106.79 | Sept. 23, 1918 |
| North Inian Pass | Icy Strait | do | do | Flashing white (flash 0.3 sec., eclipse 2.7 sec.). | 130 | 64 | 9 | 1,814.06 | Sept. 22, 1918 |
| Point Carrew | Yakutat Bay | do | do | Flashing white (flash 0.3 sec., eclipse 2.7 sec.). | 130 | 16 | 9 | 1,809.06 | Sept. 19, 1918 |
| The Eckholms | Sitka Sound | White wooden house on concrete base, 200 millimeters. | do | Flashing white (flash 1 sec., eclipse 9 sec.). | 130 | 33 | 9 | 1,794.70 | July 13, 1918 |
| Skin Island | Clarence Strait | White wooden house, L. P. 150 millimeters. | do | Flashing white (flash 1.0 sec., eclipse 9.0 sec.). | 130 | 33 | 9 | 209.67 | June 3, 1919 |
| The Brothers | Stevens Passage | White wooden house on concrete base, 200 millimeters. | do | Group flashing white (1st flash 0.6 sec., exclipse 1.8 sec.; 2d flash 0.6 sec., eclipse, 9 sec.). | 130 | 37 | 9 | 1,218.92 | May 13, 1919 |

## LIME KILN LIGHT STATION, WASH. (KELLETT BLUFF).

*Purpose.*—To meet the demands of increasing traffic between Puget Sound, British Columbia, and Alaska for suitable aids in Haro Strait, west coast of San Juan Island.

*Site.*—The station is located on a point locally known as Lime Kiln Point, on the shore of Haro Strait, westerly side of San Juan Island, Washington Sound, Wash.

*Structure.*—The main structure consists of a combined light tower and fog-signal building of reinforced concrete built on solid rock, with the base about 20 feet above high water. The light tower has a concrete deck and gallery and is surmounted by a 7 foot 1 inch helical-bar lantern. The focal plane of the light is 29 feet 7 inches above the ground floor. The roof is covered with asbestos shingles.

*Illuminating apparatus.*—The lens is of the fourth order, having three 60° panels, with a 180° spherical mirror opposite. The lens mounting is a mercury float. A 35-millimeter incandescent oil-vapor lamp is used. The characteristic is a 30,000 candlepower group flash every 10 seconds, visible approximately 13 miles. Kerosene for the lamp is stored in a tank at the foot of the tower and forced to the service-room by compressed air.

*Fog signal.*—The fog signal is a third-class reed horn operated by compressed air, sounding a group of two blasts every 20 seconds. Compressed air is furnished by a duplicate set of oil-engine-driven compressors.

*Quarters.*—The quarters, which are situated about 150 yards southeast of the main building, consist of two one-story reinforced concrete dwellings, each containing six rooms, bath, and basement. The roof is of asbestos shingles and the inside walls lathed and plastered. The landing at present is near the fog-signal building, but measures will be taken in the near future to establish a permanent landing place at Deadmans Bay, about one-quarter mile south of the reservation. A plentiful supply of water for all purposes is obtained from a 6-inch well driven in the solid rock about 100 feet southeast of the fog-signal building.

*Cost.*—The station was established June 30, 1919, under the act of July 1, 1916, appropriating $40,000 for the purpose. The amount expended to June 30, 1919, was $38,333.80. The metal work and portions of the millwork were procured by contract, and the balance of the work accomplished by the district force.

## POINT MONTARA LIGHT STATION, CALIF.

*Purpose.*—The usual track of steamers bound to and from San Francisco along this part of the coast during a fog lies between 3 and 4 miles off the station, and it therefore became necessary to install a more efficient fog-signal apparatus, and owing to its importance as a coast light the efficiency of the light was increased by changing from incandescent oil-vapor to electric incandescent. The change in illuminant was effected March 14, 1919. Change in fog-signal apparatus went into commission January 24, 1919.

*Change in light apparatus.*—The 35-millimeter, I. O. V. lamp was removed, and a 500-watt, type C, Mazda lamp was installed, candlepower increased from 2,900 to 25,000, connected to local service line 120 volts.

*Fog-signal apparatus.*—The old duplicate steam boilers, engines, and 12-inch steam whistles were entirely removed and 30-horsepower gas engines, direct-shaft connected to rotary compressors, capacity 200 cubic feet per minute at 45 pounds' pressure, were installed in duplicate; 2 vertical air receivers 60 inches diameter, 12 feet high, were installed. The air compressors operate a "G" type air diaphone at 30 pounds' pressure. Diaphone is controlled by a characteristic timer driven by a small air motor.

*Cost.*—The apparatus and materials were purchased in the open market by informal contract, and the field work was carried out by district foreman, hired labor, and assistance of the keepers. Expense was defrayed out of funds (general expenses, 1919), expended as follows:

| | |
|---|---|
| Change of illuminant | $249 |
| Change of fog-signal apparatus | 11,447 |
| Total | 11,696 |

## IMPROVEMENTS, BARTLETT REEF LIGHT VESSEL NO. 13.

*Purpose.*—To generally overhaul vessel and make necessary alterations for the installation of oil engines to operate power fog signal in tead of former bell fog signal; to improve the lighting and heating systems; to install new water tanks, fire and bilge pumps, and make necessary repairs to strengthen vessel and increase its efficiency.

*Work accomplished.*—Built and installed oil and water tanks; built two bulkheads and deck house and made necessary rearrangement of quarters; built foundations for and installed new oil engines; installed fog signal with necessary automatic apparatus; furnished and installed two air tanks, also new acetylene lights, new heating system, and fire and bilge pumps; removed standing rigging; repaired mooring chain; placed vessel on dry dock; and made necessary repairs to hull, sheathing, etc.

*Cost.*—The work was commenced in January, 1918, and completed in April, 1919. The total cost was $18,694.11.

## IMPROVEMENTS AND REPAIRS LIGHTHOUSE TENDER "ARBUTUS."

*Purpose.*—The inadequate accommodations for inspecting officers on board the tender *Arbutus* and necessity for providing quarters for a wireless operator and space for radio apparatus made it necessary to rearrange the officers' quarters and to construct additional rooms aboard this tender. The vessel was docked and given a general overhauling, the defective sheathing removed, and the hull planking recaulked. The superintendent's quarters were extended forward and a stateroom and bathroom built. The officers' quarters were rearranged and new plumbing, heating, and electric wiring provided. A mess room was built for the officers. The upper deck was recanvased. Extensive repairs in the nature of electric welding to the boilers were executed.

*Cost.*—The work was done from general expense Lighthouse Service 1918, at a cost of $27,966.74. It was started May 14, 1918, and completed October 4, 1918.

## BOILERS, LIGHTHOUSE TENDER "MARIGOLD."

*Installation of new boilers.*—New boilers of the Scotch marine type, which has been purchased previously, were installed on this vessel during the closed season of navigation 1918 and 1919. At the same time the breeching was renewed; a large portion of the main deck, which is of wood, was replaced; a new steel derrick mast was constructed and installed; a steel main rail provided in way of the main deck on each side to replace the present wood rail; and the forecastle deck raised and rebuilt in steel, sides being extended up in turtle-deck effect. In addition to the above work, the electric lighting system was overhauled; the Corey telegraph system repaired; the skylight over the after cabin removed and decked over; the mainmast cut down in size and stepped on the cabin deck, as well as other minor repairs.

The above work was done at the Detroit Lighthouse Depot by the field force of the district, the fabrication of new saddles for the boilers, new breeching, the construction of the new mast and the steelwork on the vessel, including the renewal of the main hatch and enlargement of same, being carried out on the vessel. The work of placing the boilers in position and removing the old ones was accomplished by the hiring of a derrick scow at a low cost. The work was commenced promptly after the close of the season, when the vessel was through with the buoy work, and all work was completed in readiness for her resuming her duties at the opening of navigation in spring.

*Cost.*—The work was carried out under the general-expense appropriation, the total cost of all items being $17,935.

## LIGHTHOUSE TENDER "ELM."

*Purpose.*—The tender *Elm*, a power-derrick barge, was built for the construction and repair of aids to navigation in Hudson River, N. Y., third lighthouse district.

*Structure.*—This tender is 101 feet in length overall, with a molded beam of 30 feet, and a displacement of 318 tons when floating at a mean draft of 6 feet 9 inches in salt water. It is a single-deck vessel constructed entirely of wood, except the casing around the engine space. It is fitted with a derrick mast and two booms, one 68 feet long and the other 40 feet long, with gear and tackle operated by a steam-driven hoisting engine supplied with steam by a small vertical boiler. The hoisting engine and derrick mast are located well forward, the booms swinging aft.

*Machinery.*—The propelling machinery consists of one 3-cylinder, 2-cycle, internal-combustion engine of 150 h. p., using kerosene as fuel. The cylinders are 14-inch diameter, with a stroke of 18½ inches. The engine drives a right-handed four-blade cast-iron propeller 5 feet 6 inches diameter by 3 feet 8 inches pitch. An oil-engine driven air compressor is also fitted to deliver air for running the pumps, blowing whistle, etc.

*Quarters.*—The complement of the tender is two officers and four men. There are quarters for the two officers and space for eight men, also a spare room for the superintendent or official passengers' use; the mess room, galley, wash room, and water-closet, all are located in the deck house aft on the main deck. The cargo hold is located under the main deck, and has a capacity of 70 tons. The hoisting engine and boiler are located within a house constructed on the forward end of the main deck. The necessary sanitary appliances, pumping and drainage systems have been provided.

*Cost.*—This vessel was constructed under the act of July 1, 1916, appropriating $100,000 for improving aids to navigation and establishing new aids, Hudson River, N. Y. The hull of the vessel was built under contract at East Boothbay, Me., and the cost was $29,400. The propelling machinery, hoisting engine, derrick, gear, etc., were purchased and installed by the Government for $64,238. The total cost of the vessel, complete, was $93,638. The construction was started January 13, 1917, and the vessel was completed and placed in commission July 18, 1919.

### LIGHTHOUSE TENDER "PINE."

*Purpose.*—The tender *Pine* was built for general lighthouse service in the shoal waters and inlets of the New Jersey coast, third lighthouse district.

*Structure.*—This tender is 60 feet in length overall, with a molded beam of 15 feet and a displacement of 56 tons when floating at a mean draft of 4 feet 4 inches in salt water. It is a single, open-deck vessel, constructed entirely of wood. It is fitted with a special A frame derrick, with boom and gear complete, which is operated by a gasoline-engine driven hoister, located just aft of amidships and immediately forward of the pilot house and trunk cabin.

*Machinery.*—The propelling machinery consists of one 50 h. p. 4-cylinder, 4-cycle gasoline engine, having cylinders 7½ inches in diameter and 10-inch stroke, driving a right-hand 3-blade bronze propeller 36 inches in diameter by 40 inches pitch. There are also provided two gasoline tanks of 300 gallons total capacity, and two fresh-water tanks of 300 gallons total capacity. Necessary sanitary appliances and bilge drainage pipes have been provided.

*Quarters.*—The complement of the tender is two officers and three men. Berths are provided in the after part of the pilot house and in the trunk cabin under the pilot house for the officers and men, respectively. The cargo hold is located under the main or buoy deck forward and has a capacity of 16 tons.

*Cost.*—This tender was constructed under the appropriation "General expenses Lighthouse Service, 1918," the vessel being built under contract at Nyack, N. Y.. the contract price was $9,500. An A frame derrick with boom and gear, operated by a gasoline hoisting engine, was purchased and installed by the Government at a cost of $6,687. The construction was commenced June 27, 1918, and the vessel completed and placed in commission November 11, 1918, at Tompkinsville, N. Y.

## SUMMARY OF IMPORTANT CONSTRUCTION AND REPAIR WORK UNDER GENERAL APPROPRIATIONS COMPLETED DURING FISCAL YEAR 1919.

| Station. | Cost. | Character of work. |
|---|---|---|
| FIRST DISTRICT. | | |
| Tender Hibiscus | $10,029 | Docking vessel, repairing hull, boilers, machinery, heating system, lighting and piping, also making alterations to houses, etc., to accommodate radio outfit and attendants. |
| Portland Light Vessel, No. 74 | 3,425 | Docking vessel, repairing hull, retubing and repairing boilers, repairing machinery, and installing new pump. |
| Little Diamond Island Lighthouse Depot, Me. | 4,268 | Renewing part of bearing and fender piles, caps, braces, and dock. |
| Seguin Light Station, Me | 1,038 | Installing hot-water heating plants in both sets of quarters in brick house. |
| SECOND DISTRICT. | | |
| Tender Mayflower | 6,735 | Docking, cleaning, painting, etc. |
| Tender Anemone | 2,764 | Docking, painting, etc. |
| Boston Light Station, Mass | 4,351 | Installing oil engines and air compressors and making necessary alterations to buildings. |
| Light Vessel No. 42 | 4,900 | Docking, cleaning, etc. |
| Light Vessel No. 86 | 1,015 | Docking, painting, etc. |
| Pig Rocks Light, Mass | 2,243 | Establishing acetylene light in place of beacon. |
| Canal Channel Light No. 8, Mass | 2,000 | Protecting site with riprap. |
| Canal Channel Light No. 16, Mass | 2,500 | Do. |
| Canal Channel Light No. 15, Mass | 2,500 | Do. |
| Canal Channel Light No. 18, Mass | 1,750 | Do. |
| Canal Channel Light No. 20, Mass | 3,000 | Do. |
| Canal Channel Upper Range, Mass | 3,500 | Do. |

## SUMMARY OF IMPORTANT CONSTRUCTION AND REPAIR WORK UNDER GENERAL APPROPRIATIONS COMPLETED DURING FISCAL YEAR 1919—Continued.

| Station. | Cost. | Character of work. |
|---|---|---|
| THIRD DISTRICT. | | |
| General depot | $1,029 | Retubing boiler (No. 1), power house. |
| Do | 1,078 | Installing new concrete roadway around new carpenter shop and in front of same. |
| Do | 3,711 | Rearranging drainage and sewer system made necessary by building new office building. |
| Absecon Light Station, N. J. | 1,050 | General repairs to keeper's quarters. |
| Borden Flats Light Station, Mass. | 1,315 | Replacing wooden walls to kitchen coal bin and privy with tile. Providing and installing water-closet. Renewing concerte deck, main gallery. |
| Eatons Neck Light Station, N. Y. | 1,951 | Reshingling roof, renewing gutters, and making various repairs. |
| Execution Rocks Light Station, N. Y. | 2,498 | Temporary compressed air siren installed Dec. 17, 1918, in place of former fog signal destroyed by fire. |
| Sakonnet Breakwater Light Station, R. I. | 1,420 | Establishing flashing acetylene light on breakwater. |
| Tender Daisy | 1,818 | Repairs to damaged bow and annual docking and painting. |
| Tender Mistletoe | 4,562 | Annual overhauling and repairs. |
| Tender Myrtle | 2,422 | Putting in dry dock and repairing sheathing metal. |
| Tender Pine | 6,687 | Installing derrick, hoister, etc., to complete vessel for service. |
| Tender Tulip | 4,242 | Docking and painting, installing new propeller blades, repairing boilers, hull, and machinery and installation. |
| Do | 5,338 | Docking, painting, and general repairs. |
| Do | 2,922 | Building and installing new steel derrick boom, and general repairs to hull and machinery. |
| Scotland Light Vessel No. 11 | 7,785 | Docking, repairing sheathing metal, building wireless room, installing acetylene lights, etc. |
| Bartlett Reef Light Vessel No. 13 | 8,067 | Placing vessel in dock and repairing keel, sheathing metal, etc. |
| Ram Island Reef Light Vessel No. 23 | 3,681 | Docking and necessary repairing. |
| Northeast End Light Vessel No. 44 | 2,487 | Docking and general repairing of hull and machinery. |
| Cornfield Point Light Vessel No. 48 | 1,312 | Docking and repairing sheathing metal; also general repairs to hull and machinery. |
| Fire Island Light Vessel No. 68 | 3,250 | Installing acetylene lights in place of present electric lights and general repairs to hull and machinery. |
| Overfalls Light Vessel No. 69 | 1,950 | General repairs and annual overhauling. |
| Relief Light Vessel No. 78 | 2,468 | Docking and repairing damages caused by collision. |
| Five Fathom Bank Light Vessel No. 79. | 4,080 | Docking and painting, general repairs to hull and machinery, and rearranging houses for wireless. |
| Ambrose Channel Light Vessel No. 87 | 1,313 | Docking, painting, and general repairs. |
| FOURTH DISTRICT. | | |
| Edgemoor Lighthouse Depot, Del. | 1,929 | Thirty-two wharf fender piles put in place, and buildings painted two coats. |
| Schooner Ledge Range Rear (unused) Light Station, Pa. | 2,185 | Tower dismantled and put on cars for rail shipment. |
| Cape Henlopen Light Station, Del. | 5,483 | Bulkhead erected and groynes repaired. |
| Tender Iris | 29,615 | General repairing; cylinders rebored; new liner made and fitted, etc. |
| Tender Woodbine | 3,431 | Old sheathing removed from hull and resheathed; cylinders of engine opened; new rings made. |
| FIFTH DISTRICT. | | |
| Chincoteague Lighthouse Reservation, Va. | 3,285 | Building concrete retaining wall; installing boat davits. |
| Buoyage | 3,017 | Converting two type C buoys to use compressed acetylene gas. |
| Dutch Cap Cutoff Light, Va. | 1,554 | Establishing acetylene light; discontinuing light station. |
| Cape Lookout Light Vessel No. 80 | 9,269 | Docking, painting, and making minor repairs to hull and machinery. |
| Tender Juniper | 1,785 | Overhauling boilers, making repairs to deck by district force. |
| Tender Jessamine | 19,331 | Docking, repairing deck, hull, and boilers. |
| Tender Arbutus | 27,967 | Docking vessel and altering and improving quarters. |
| Relief Light Vessel No. 49 | 15,676 | Docking, replanking hull, and making general repairs. |
| Tender Laurel | 5,238 | Docking, repairing sheathing, etc. |
| Tail of Horse Shoe Light Vessel No. 46. | 3,864 | Docking, painting, and making minor repairs. |
| Winter Quarter Light Vessel No. 91 | 6,203 | Do. |
| Working barge | 3,956 | Building deck house and installing plumbing. |
| Working barge and pile driver | 8,415 | Docking, resheathing, making general repairs to hull. |
| North River Bar Range Lights, N. C. | 2,367 | Rebuilting front light and increasing intensity of both lights. |
| Tender Columbine | 1,190 | Docking, cleaning, painting, and making minor repairs |

## SUMMARY OF IMPORTANT CONSTRUCTION AND REPAIR WORK UNDER GENERAL APPROPRIATIONS COMPLETED DURING FISCAL YEAR 1919—Continued.

| Station. | Cost. | Character of work. |
|---|---|---|
| SIXTH DISTRICT. | | |
| Charleston Light Station, S. C. | $1,972 | Rebuilding walk from wharf to station, increasing size of wharf, raising tramway to boathouse, and minor repairs. |
| Hunting Island Light Station, S. C. | 2,928 | General repairs to buildings and tramway. |
| Tender Cypress | 2,560 | Docking, cleaning, painting, and overhauling, and repairing boilers and machinery. |
| Tender Palmetto | 2,417 | Docking, cleaning, painting, repairing steering gear, machinery, and electric-lighting equipment. |
| Martins Industry Light Vessel No. 1 | 3,387 | Docking and renewing hull sheathing, new rudder, etc. |
| Brunswick Light Vessel No. 84 | 6,605 | Docking, cleaning, painting, installing new main condenser, machinery repairs, etc., at Charleston Navy Yard. |
| Relief Light Vessel No. 53 | 2,430 | Docking, cleaning, painting, repairing hull, boilers and machinery. |
| SEVENTH DISTRICT. | | |
| Beacons and unattended lights | 3,113 | Making minor repairs to and painting. |
| Inside Route Beacons (Miami to Long Key, Fla.). | 1,778 | Establishing 93 single pile beacons. |
| Miami and Cape Florida Channels, Fla. | 5,416 | Establishing 3 triangular, pyramidal, wooden structures and 17 5-pile dolphins with minor lights, and 54 single-pile beacons. |
| Pine Island Sound Lights Nos. 4, 8, 14, 3, 19, and 15, Fla. | 1,208 | Replacing single piles with 5-pile dolphins. |
| Southwest Channel Light, Fla | 1,430 | Rebuilding structure. |
| Tender Ivy | 3,937 | Docking vessel, scaling and painting hull, overhauling and repairing main engines, and repairing 2 dynamos; rearranging quarters of crew and petty officers; making various repairs. |
| Tender Snowdrop | 3,528 | Renewing all cabin and house work; minor repairs to hull and machinery. |
| EIGHTH DISTRICT. | | |
| Galveston Jetty Light Station, Tex | 8,733 | 1,093 tons of rock were placed around foundation. |
| Heald Bank Light Vessel No. 81 | 3,982 | General repairs to hull and machinery. |
| Southwest Pass Light Vessel No. 102 | 1,212 | Minor repairs to hull and machinery. |
| West Pass Cut Range Lights, Fla | 2,364 | Rebuilding both 4-pile iron-cased structures. |
| Tender Camellia | 3,650 | Docking and repairing. |
| Tender Magnolia | 24,034 | General repairs to boilers, hull, and machinery. |
| NINTH DISTRICT. | | |
| Tender Lilac | 2,755 | Installing creosoted wooden false keel, docking vessel, and painting hull. |
| TENTH DISTRICT. | | |
| Buffalo Lighthouse Depot | 5,494 | Extensive repairs to old boat slip and wharf. |
| Cleveland East Entrance Light Station, Ohio. | 6,262 | Providing new steel tower and installing diaphone in place of electric sireno fog signal. |
| Cleveland West Pierhead Light Station, Ohio. | 1,365 | Improvement to fog signal building. |
| Galloo Island Light Station, N. Y. | 3,384 | Rebuilding wharf (timber). |
| Lorain West Breakwater Pierhead Light Station, Ohio. | 5,530 | Improvements to structure, installing fog signal apparatus, and necessary repairs. |
| Oswego Light Station, N. Y. | 2,424 | Extensive repairs to foundation crib and minor repairs to boathouse. |
| Presque Isle Fog Signal Station, Pa | 1,196 | Repairs and improvements to fog-signal house. |
| Tender Crocus | 4,617 | Docking, painting, miscellaneous repairs and improvements, and repairing cargo boat. |
| ELEVENTH DISTRICT. | | |
| Tender Marigold | 17,935 | Installing new boilers; replacing breeching; overhauling machinery; building and installing new steel mast; raising forecastle head; enlarging main hatch; renewing greater part of main deck; installing steel main rail and making minor repairs. |
| Windmill Point Light Station and Windmill Point Range Light Station, Mich. | 2,502 | Raising front and rear towers, 15 and 20 feet, respectively installing bathrooms in each dwelling; installing electric lights in dwellings and towers. |
| Clinton River Range Lights, Mich | 1,453 | Building new tank house and mast at front light and installing A. G. A. light at both front and rear lights. |
| West Neebish Channel Light No. 5, Mich. | 1,655 | Rebuilding pile-light structure in readiness for new lighting. |
| Au Sable Light Station, Mich | 1,146 | Repairing and rebuilding landing dock. |
| Big Bay Light Station, Mich | 1,297 | Repairing and rebuilding landing dock at boathouse placing new fog signal doors. |
| Outer Island Light Station, Mich | 3,809 | Repairing and rebuilding landing dock, repairing tramway and making minor repairs around station. |
| La Pointe Light Station, Mich | 1,670 | Repairing landing dock; installing electrically controlled fog bell, and telephone. |

## SUMMARY OF IMPORTANT CONSTRUCTION AND REPAIR WORK UNDER GENERAL APPROPRIATIONS COMPLETED DURING FISCAL YEAR 1919—Continued.

| Station. | Cost. | Character of work. |
|---|---|---|
| TWELFTH DISTRICT. | | |
| South Fox Island Light Station, Mich. | $1,997 | General repairs to station buildings; dock rebuilt and complete system concrete walks placed. |
| Frankfort Pierhead Light Station, Mich. | 5,325 | Fog signal improved by installing electric driven air compressor and air diaphone to replace blower siren. Front and rear range lights improved by installing electric lamps to replace wick oil lamps. |
| Portage Lake Pierhead Light Station, Mich. | 1,137 | Front light of range discontinued; rear light changed from oil to unwatched acetylene and elevated walk removed. Keeper discontinued. |
| Pentwater Pierhead Light Station, Mich. | 1,783 | Front and rear lights of range changed from oil to acetylene and elevated walk removed. Keeper discontinued. |
| St. Joseph South Pier Light Station, Mich. | 3,557 | New light established; concrete foundation constructed and skeleton steel tower erected and acetylene light apparatus installed. |
| Waukegan Harbor Light Station, Ill. | 1,262 | Two bathrooms built in first story of double dwelling and fixtures moved from basement. Minor repairs to fog-signal building. Concrete sea wall built about base of breakwater tower. |
| Pottawatomie Light Station, Mich., and Suel Choix Pointe Light Station, Mich. | 2,492 | Two launches, with engines, contracted for to replace two worn out. |
| Green Island Light Station, Wis. | 1,780 | Replacing old launch with a new one. |
| Tender Sumac | 1,483 | Do. |
| Do | 2,117 | General repairs to hull, boilers, and machinery. |
| Relief Light Vessel No. 98 | 1,164 | Hull of vessel provided with an insulating lining, and heating system improved. |
| THIRTEENTH DISTRICT. | | |
| Barge for tender Dandelion | 7,150 | Constructing barge. |
| FIFTEENTH DISTRICT. | | |
| Tender Oleander | 7,808 | Rebuilding boiler deck; building and installing new heaters; rebuilding cold storage room and furnishing and installing new brine tank; rewiring in conduit; renewing main and branch steam lines; and renewing auxiliary steam pipe. |
| SIXTEENTH DISTRICT. | | |
| Mary Island Light Station, Alaska | 1,158 | Building addition to boathouse, installing new turntable, making miscellaneous repairs about station. |
| Tree Point Light Station, Alaska | 1,785 | Miscellaneous repairs to tower, dwellings, and tram. |
| Tender Cedar | 5,469 | Docking, cleaning, painting, general repairs, and improvements. |
| Tender Fern | 3,900 | Docking, cleaning, painting, general repairs, including enlargement of deck house and installation of wireless apparatus. |
| SEVENTEENTH DISTRICT. | | |
| Browns Point Light Station, Wash. | 2,010 | Repairing buildings, fencing grounds, and grading. |
| Robinson Point Light Station, Wash. | 6,268 | General repairs to assistant keeper's dwelling, grading of roads, etc. Illuminant and motive power of fog signal changed to electricity. |
| Tender Manzanita | 2,016 | Installing steel fore topmast, docking, cleaning, and painting, and general repairs to machinery. |
| Tender Heather | 1,276 | Docking, cleaning, and painting, also overhauling of steering engine. |
| Tender Rose | 1,066 | Docking, cleaning, and painting, and installation of ventilator and additional sanitary fittings. |
| Columbia River Light Vessel No. 88 | 1,895 | Docking, cleaning, painting, and general overhauling. |
| Relief Light Vessel No. 92 | 3,668 | Do. |
| Swiftsure Bank Light Vessel No. 93 | 4,383 | Do. |
| EIGHTEENTH DISTRICT. | | |
| Alviso Channel Light 10, Calif. | 1,486 | Establishing a 3-pile beacon and acetylene light. |
| Crescent City Entrance Gas and Bell Buoy No. 2, Calif. | 2,200 | Establishing gas and bell buoy. |
| Humboldt Bay Fog Signal and Lights, Calif. | 1,042 | A 30-foot extension to present landing dock was built. |
| Humboldt Bay Fog Signal and Lights, Calif. | 1,721 | Brush fascines were laid and covered with heavy riprap stone to protect timber revetment and sheet piling from action of heavy seas. |
| Lighthouse Depot, Goat Island, Calif. | 1,887 | Two-room additions were built to the machinist's and blacksmith's quarters. |
| Mile Rocks Light Station, Calif. | 1,222 | Installing air diaphone in place of 10-inch air whistle. |
| North Channel Gas Buoy, No. 1, Calif. | 1,050 | Establishing a type S acetylene-gas buoy. |
| Point Arena Light Station, Calif. | 2,039 | Installing air diaphone in place of air siren. |

### SUMMARY OF IMPORTANT CONSTRUCTION AND REPAIR WORK UNDER GENERAL APPROPRIATIONS COMPLETED DURING FISCAL YEAR 1919—Continued.

| Station. | Cost. | Character of work. |
|---|---|---|
| EIGHTEENTH DISTRICT—continued. | | |
| Point Montara Light Station, Calif. | $11,437 | Installing air diaphone, distillate engines, and rotary air compressors in duplicate in place of duplicate steam boilers and 12-inch steam whistles. |
| San Mateo Light No. 2, Calif. | 1,390 | Establishing a 3-pile beacon and acetylene light. |
| Santa Cruz Light Station, Calif. | 1,060 | Building new entrance gateways (2) and rebuilding outer reservation fence. |
| San Pedro Entrance Light No. 2, Calif. | 1,422 | Structure rebuilt and oil equipment changed to acetylene equipment. |
| St. George Reef Light Station, Calif. | 1,228 | Electric-driven motor hoist, in portable housing, to lift up station launch on landing dock at Crescent City. |
| Tender Madrono | 3,872 | Installing radio set. |
| Do | 1,043 | Docking, general overhauling, and repairs to hull, boilers, engine, and machinery. |
| Relief Light Vessel No. 76. | 1,274 | Do. |
| San Francisco Light Vessel No. 70. | 3,102 | Docking, general overhauling and repairs to hull, boilers, engine, and machinery, including renewing of entire lower part of 1 bulkhead. |
| NINETEENTH DISTRICT. | | |
| Makapuu Point Light Station, Hawaii. | 2,568 | Repairs to over five miles of station roadway; erected 900 feet of fence on cliff roadway, using reinforced concrete posts. Screened three dwellings; renewed damaged sections and painted about two miles of pipe line; erected a fence around the tower; increased size of paddock at barn with rock fill; and made repairs to reservation and station roadway. |

# REPORT

OF THE

# SUPERINTENDENT, U. S. COAST AND GEODETIC SURVEY

# REPORT

OF THE

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DEPARTMENT OF COMMERCE,
COAST AND GEODETIC SURVEY,
*Washington, October 4, 1919.*

SIR: There is submitted herewith my fifth annual report as Superintendent of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1919. This is the eighty-eighth annual report of this Bureau.

### PART I.

Chapter I: Condition of the Washington office of the Bureau, pages 789 to 802.

Chapter II: Work of the Washington office of the Bureau during the fiscal year, pages 803 to 812.

### PART II.

Chapter I: Statement of the needs of the Bureau better to accomplish its field work, pages 813 to 822.

Chapter II: Discussion of the field accomplishments during the year, pages 823 to 830.

Chapter III: Showing conditions and needs of surveys, hydrographic and geodetic, with illustrations—United States and possessions, pages 831 to 851.

### PART III.

Chapter I: War work of the Bureau, pages 852 to 856.

### PART IV.

Résumé of the work accomplished in the field and office during the year, pages 85 to 923.

## INTRODUCTION.

Charts, as produced by the United States Coast and Geodetic Survey, are the direct means of protecting from loss the vessels of our Navy, Coast Guard, and merchant marine, thereby also protecting human lives and commerce. The charts are produced only by this Bureau and reach their high degree of value to the navigator only when they give *accurate* as well as the fullest information.

The honest and candid statement which the public should have put before it at this time is that these charts, which should now be expedited in their production and carry accurate and vital knowledge to all who need it, are in a measure losing the value they should have. This may seem a startling statement, and it is a deplorable one to have to make, but there is a reason for it. It is a workable problem with but the one answer. To keep these necessary charts in the hands of all who demand them, both field and office forces of the Bureau must be kept in the highest form. The work is absolutely necessary; it can not be accomplished without sufficient funds, which are not now provided; therefore, an adequate appropriation is the only remedy.

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[a] Forty-six illustrations appeared in the pamphlet edition of the Superintendent's report, but are omitted from this volume.

The present condition is caused entirely by *lack* of funds—funds sufficient for modern surveying vessels, and funds to operate same; also funds to enable us to secure able officers and crews, with salaries adequate to hold them. This is for the field work, which is but the beginning of the labor. Again, funds are needed for the office work. Highly trained men are necessary properly to care for the data which are to go on the charts, and those we have are so much underpaid, besides lacking in sufficient numbers, that they are leaving the Bureau for better salaried positions.

Indeed, the condition in the Coast and Geodetic Survey is so serious that it threatens to jeopardize the public welfare.

The large number of recent resignations from the commissioned personnel and from the other scientific arms of the Bureau, in fact from all classes of the service, will continue more rapidly unless checked by meeting the situation *very soon* face to face.

The commissioned officers are the lowest paid men of their training in the Federal service. Their salaries, compared to those paid in the Army and the Navy for similar qualifications, are from 30 to 50 per cent less. Much of their work is more hazardous, requires special training, and takes them into all our country's possessions as the pioneer workers or the navigators—surveyors who " blaze the trail " on land and sea—and no Army or Navy officer has greater qualifications, nor do they sacrifice more than the officer of the Coast and Geodetic Survey; yet the latter works for much the lowest salary, gets no longevity pay, no emoluments, and after he has given his best years in the service of his country he must retire *without* pay.

Many of the Bureau's officers are just waiting, believing that Congress will properly recognize this harmful and unjust condition.

In the chapters to follow, under separate headings, I have endeavored to try again, by further emphasis and explanation, to show what has caused this certain disintegration, with the hope that relief will be immediately forthcoming, and thereby save further inroads on the proper functioning of this important Bureau.

# Part I.—CONDITION AND WORK OF THE WASHINGTON OFFICE.

## CHAPTER I.

### CONDITION OF THE WASHINGTON OFFICE.

Too few persons realize the sacrifices a man of ability is making at the present time by remaining in the Coast and Geodetic Survey. Before this country entered the war conditions had grown to a serious stage, but since the signing of the armistice steady disintegration has gone on, and the situation has reached a point where the quality of the Survey's employees is declining principally under the stress of present economic conditions. Unless proper relief is forthcoming *at once*, and the present salaries are materially advanced, this important branch of the Federal Government, which has so much to do with the protecting of human lives, will, in a measure at least, be stripped of its best brains.

There are three definite and logical reasons for this situation:

1. The sorrowful tradition that Federal employees should not expect to be paid even nearly as much as though they were working for some private corporation or firm.
2. The high cost of living, and that in the more than 100 years of existence of this Bureau during which some salaries have not been increased.
3. The unfortunate and unbusinesslike method of submitting lump-sum appropriations to be used to pay salaries far in advance of those received by men and women doing similar, and in many cases, higher-grade work, and who are paid from statutory salaries which are antiquated and unjust, because they were made for conditions a decade or more ago.

Out of these conditions has arisen the state of affairs with respect to each of the different classes of employees of this Bureau mentioned below:

#### DRAFTSMEN.

The salaries of hydrographic and topographic draftsmen (cartographers) in the Coast and Geodetic Survey range from $1,000 to $2,400 per annum. In various Government bureaus where employees are paid from lump-sum appropriations the salaries are often double those given above. For example, in the Navy Department, the Bureaus of Steam Engineering, Construction and Repair, and Yards and Docks have adopted the Macy award for draftsmen, which award is also in effect in all shipyards in the United States. A comparison of the salaries established under this award with those paid in the Coast and Geodetic Survey for work of *equal importance* and requiring equivalent technical qualifications indicates the following:

| MACY AWARD. | | COAST AND GEODETIC SURVEY SALARY FOR CORRESPONDING POSITION. | |
|---|---|---|---|
| Chief draftsman | $5,634 | | |
| Assistant chief draftsman | 4,945 | Chief draftsman | $2,400 |
| Supervising draftsman | 4,006-4,257 | Assistant chiefs of sections | 2,200-2,400 |
| Chargeman | 3,130-3,756 | Expert cartographers | 2,000-2,200 |
| Draftsman, grade A | 2,504-3,005 | Cartographers and cartographic draftsmen | 1,000-2,000 |
| Draftsman, grade B | 1,878-2,254 | | |
| Draftsman, grade C | 1,627 | | |
| First-class copyist | 1,252-1,502 | Copyist draftsmen | 1,000 |
| Second-class copyist | 1,001 | | |

For the entrance grade of topographic draftsman, for which this Bureau pays $1,000 per annum, the War Department offers $2,100 per annum. The qualifications for the two positions are identical. Salaries paid outside the Government service are comparable with those established by the Macy award given above.

As this report is being written, I have before me for acceptance the resignation of one of our draftsmen who has been with us more than nine years, whose basic pay is now but $1,400 per annum, and who is going to a position that pays him $2,600 per annum. Another draftsman recently left this Bureau who had not the basic education to reach the higher grades in our technical work. His basic pay here was $1,400. He immediately accepted a position as a draftsman in another branch of the Government service at $1,800 per annum.

The result of this situation is that our trained cartographers are resigning to obtain elsewhere the adequate compensation which is denied them in this Bureau. At this present time we have 28 positions for draftsmen, 11 of which are vacant or filled by temporary employees (persons who have not the qualifications for permanent appointment, but whose services are used with the hope of some advancement in utilizing the bulk of data that have accumulated in the office). In other words, only about two-thirds of our drafting force of only 28 are capable of any independent effort in digesting the mass of accumulated data that we have before us. In spite of the fact that the requirements have recently been so amended as to permit of our accepting high-school graduates, we are unable to obtain candidates to fill the vacancies thus created. This force, without which charts can not be produced, is at present actively disintegrating. Such disintegration can be checked only by a material increase in all grades of pay. Unless it is checked it will reach the point where the Bureau will be unable to produce the corrected charts on which the safety of navigation directly depends.

This deplorable situation, which is definitely affecting the highest efficiency of our charts, has been repeatedly emphasized, both publicly and in my annual reports, but without receiving the slightest relief. These men deserve much credit for remaining in their positions so long, and their loyalty, in the face of underpay and miserable quarters to work in, is highly creditable.

### COMPUTERS.

We have need for many more computers than are authorized in the present appropriation bill, and the entrance and lower-grade salaries should be made higher. I shall mention only the salient points, and not go into lengthy details. The geodetic surveys of this Bureau are broad and comprehensive. Our schemes of triangulation extend all over continental United States, and are the framework on which are based, and which furnish the controlling positions for, operations (Government, State, and county) of less extensive character. Necessarily, over such a broad and comprehensive scheme the arcs of triangulation extended over great areas and the stations marking the points of triangulation were widely separated. Likewise, lines of precise levels stretch far across the continent. The outcome of this was that the publications that have been issued by this Bureau giving the geographic positions and descriptions of triangulation stations and the descriptions and elevations of precise-leveling stations have contained, and now contain, the data for many States in the Union. That is to say, that our triangulation publications have been issued so that each contains a particular arc of triangulation without reference to the political boundaries of the area covered, and these arcs sometimes extend through two or three States of the Union, and the publication containing our precise levels has data for all of the States of the Union. Heretofore the inducement for issuing these publications in this form has been that the scheme for triangulation and levels has been so large that the points contained in any one political division were so small in number that in but few instances would there have been justification for issuing a publication containing these data for any one State in the Union. These observations have now progressed to such a point that each class of publication contains a very great number of positions, elevations, and descriptions of triangulation and precise-leveling stations in most of the States of the Union, so that it is now wasteful to distribute them in the form in which they have been issued heretofore, because the recipient is interested only in data for his particular locality. A marked economy would be effected by issuing a single publication for each State in the Union, in which would be assembled all geodetic data that have resulted from observations to date of issue. Such a publication would concentrate much information that is of great and valuable service to local surveyors, and the information would be in such form that it would be readily accessible.

To do this on a practical and satisfactory basis would require that each publication thus issued for each State in the Union should contain, not only the essential geographic positions that have been computed for the large arcs of triangulation that extend over the whole country, but the geographic positions and descriptions of every minor point of triangulation that has been determined in conjunction with the larger basic observations; and here is where we are hopelessly swamped with our present computing force. There are portfolios of field observations containing thousands of such stations in the archives of this Bureau that have never been computed. Indeed, so inadequate is our computing force to meet the present needs that we have adopted the expedient of putting into print the results from the latest field work, and gradually working backward into the old material. This is believed to be a very much better method than to go back to the old work first, for if this were done the most recent work would be very many years old before it could be put into print. As it is, the public is deprived of the benefits of this information that has cost many years of effort to obtain, as well as many thousands of dollars. The cost of the computation and printing would be but a fractional part of the expenditures that have already been made.

The entrance salary for computers should be $1,600 per annum rather than $1,200, and the number of positions in the higher grades should be increased. The entrance salary of $1,200 per annum is too low to command the interest of men capable of doing this work. Those who come to us at this salary and learn of the meager prospects of advancement stay but a short while. The men who lingered but a short while were 31 during the past fiscal year, and of the 11 positions at $1,200 per annum 9 are now filled by temporary employees.

### ENGRAVERS.

In no section of the Bureau is the antiquity and inadequacy of the existing salary scale more strikingly exemplified than in the engraving section. The sundry civil act for 1920 increased two $1,000 positions to $1,200; with this exception there has been for years no increase either in compensation or in the number of employees. The salaries range from $1,000 to $2,400; in a total force of 19 men the average salary is $1,621.

Two of these men have been appointed recently. The remainder have served in the Bureau for periods ranging from 9 to 60 years. The average length of service is 22 years. The man who has served only 9 years receives $1,000 per annum. He is a skilled engraver, thoroughly competent, who during all that period has never been denied a promotion to an existing vacancy. He has gone ahead, in his regular order, from an entrance salary of $504 per annum to his present salary of $1,000.

Why, it will be asked, do men stay in positions which pay such inadequate salaries? The answer is that copperplate map engraving is a distinct profession practically limited in this country to this and one or two other Government bureaus. If they resign here, they must start in at the bottom in some other department where advancement is also slow, and where they lose the credit for their previous years of service. There is no field for them in commercial life, so if they seek work outside it must be along other lines, and this does not appeal to them. Engraving is an art, not a trade, and the man who becomes a skilled engraver must have something of the temperament which compensates the artist for the sacrifices he often endures while he is painting his masterpiece.

Yet the very fact that this work is so highly specialized affords the strongest argument for according the men such justice that they will not be tempted to resign. If one of these men should go, it would take years to replace him. There is no outside source of supply of men having the required skill. They must be trained within the Bureau, and it requires a period of years before the apprentice becomes sufficiently skilled in all details to be intrusted with the production of a new chart.

In contrast with this salary scale it is interesting to note that in effect in the Bureau of Engraving and Printing. That bureau employs 32 engravers, whose salaries range from $1,500 to $7,500 per annum. The average salary of the 32 positions is $3,003, or almost double that of the engravers in this Bureau. The calibers of the men required by the two bureaus are fairly comparable, since any possible difference in artistic qualities of the work is fully compensated for by the mathematical accuracy required of the map engravers.

Not only should the salaries of the engravers be raised, but the number of employees in the section should be increased. The work which the section is called upon to do has increased materially in recent years. In 1901 the number of charts issued to the public was 64,496; in the fiscal year 1919 it was 290,537. During the same period the amount of original data received by the Bureau to be utilized in the production of new charts or the correction of existing ones increased over 150 per cent. Yet during that same period the force of engravers increased only from 17 in 1901 to 19 in 1919. This ever-growing discrepancy between public demand and available data on the one hand, and available force on the other, has been one of the factors responsible for the long delays in furnishing to the public the results of new surveys in the form of modern and correct charts, and even, in some cases, for the inability of the Bureau to utilize at all the data received.

This increase in force need not be proportional to the increased demand upon the Bureau, as indicated by the above comparison. Increases in a much smaller ratio will be entirely adequate. Also, the increase should be made gradually, as the section can not afford to reduce the time devoted to chart production as would be necessary if it attempted to train any considerable number of inexperienced men at one time. Next year the force should be increased by at least three men, and further increases should be postponed until the training of these three is well under way.

### CLERKS.

The salaries paid clerks in the Coast and Geodetic Survey are below the average in the Government service. During the fiscal year for which this report is made, the average pay for clerks in the Coast and Geodetic Survey was lower than the average pay for clerks in the Department of Commerce or any bureau thereof. The average pay for clerks in the Department of Commerce as a whole for the fiscal year 1919 was $1,211.60, and the average pay in the Coast and Geodetic Survey for clerks was $1,130.24. During the fiscal year for which this report is made, the entrance salary for clerks in this Bureau has been $720 per annum. The lower House of Congress has recognized the necessity of a general increase in all the lower paid positions in the Federal service, so that no employee above 18 years of age, whether laborer, messenger, watchman, or charwoman, will receive less than $1,080 per annum. These are the provisions of the Nolan bill, which has passed the lower House. If, then, employees such as messengers, laborers, etc., performing duties that require no training or education to establish their fitness for the position held are to receive $1,080 per annum, surely it is proper that the entrance salary of a clerk who must spend time and money to fit himself to perform his duties should be more than $1,080 per annum.

The Coast and Geodetic Survey is a technical bureau, and the scientific nature of the work of the Bureau permeates all its branches. It requires a much higher grade of intelligence, and closer application for a clerk to perform his duties satisfactorily where the duties of the branch to which he is assigned are different from those of any other branch of the Bureau, and where he is thrown on his own initiative, than where the work is largely routine, and where a number are performing the same duties, and the clerical personnel is readily interchangeable, as is the case in many other branches of the Government service. In those branches, numbers of clerks are performing the same class of work and under the immediate supervision of directors, but in the Coast and Geodetic Survey the clerk must be put on his own resources as to his accomplishment. In proof of the statement that the clerical employees of the Coast and Geodetic Survey have average, or higher than average, ability the statement needs only to be made that, during the fiscal year, 66 clerks left the Coast and Geodetic Survey, many to higher-paid positions in other branches of the Government service, while it *never* occurs that a clerk comes to the Coast and Geodetic Survey at a higher salary than he received in another branch of the Government service. Instance after instance can be cited where clerks leave the Coast and Geodetic Survey for higher salaries. One employee served as a clerk in this Bureau at $720 per annum from February 26 to May 22, 1918, and was replaced by another employee at $720 per annum because she had not the requisite training to handle the work in this Bureau. Immediately afterwards she obtained employment as a clerk in the Treasury Department, and is now employed in that capacity in that department permanently at a salary between $1,300 and $1,400 per annum. Here is a case of a clerk who had not the ability to perform the duties required in this Bureau, and yet she went to another department and was paid a salary that could be gained only after years of service in the Coast and Geodetic Survey.

Another clerk entered the Coast and Geodetic Survey December 18, 1912, and served until January 5, 1918, by which time he had been promoted to $1,200 per annum. He was then drafted into the Army. On his discharge from the Army he sought reinstatement in the Coast and Geodetic Survey, but the only vacancy then existing was one at $900 per annum. This he refused to accept, and sought employment elsewhere. He is now employed as a clerk in the Bureau of War Risk Insurance at a salary of $1,400 per annum. Here is an instance of a clerk *entering* another branch of the Government service as a clerk at a much higher salary than he had attained in the Coast and Geodetic Survey after nearly six years of service. The clerks now receiving salaries of $1,200 per annum in the Coast and Geodetic Survey have served an average of 12 years.

Many other parallel cases could be cited, as there has been instance after instance of transfers from the Coast and Geodetic Survey clerical roll to higher-paid positions in other branches of the Government service. Long before the end of the war and before the demand for clerical help had become acute, there had been many tempting offers to clerks in this Bureau to transfer to other positions and other branches of the Government service at much increase in salary, and during the press of the war the opportunities were without number.

A clerical employee in the Coast and Geodetic Survey is under some disadvantage. It is a specialized class of work. In nearly every instance, no matter how proficient the clerk becomes in performing his duties in the Coast and Geodetic Survey, he does not acquire skill and knowledge that he can use in other walks in life. He is taken out of the channels of ordinary activity, and his acquirements in the Coast and Geodetic Survey generally are marketable nowhere else. For example, no matter how proficient a clerk may become in the tidal or magnetic divisions, the knowledge and skill required are of use in only the respective branches of this one service. Even the correction of our nautical charts requires extreme accuracy and considerable dexterity, and yet there are very, very few places outside of the Coast and Geodetic Survey where knowledge and skill thus gained can be put to account. Even the auditing of the accounts of our field parties requires special knowledge of the methods of this Bureau, and a very specific knowledge of the Comptroller's decisions respecting the expenditure of Government funds. In whatever division or section of the Coast and Geodetic Survey a clerk is employed he is useful largely because of his knowledge of the procedure in carrying out the technical work of the Bureau. It, therefore, follows that the longer a clerk of average intelligence is employed in the Bureau the more value he is to the Bureau, and the less able to use this knowledge elsewhere. The results of the work of the Coast and Geodetic Survey are necessary for the welfare of the Nation. Somebody must carry on the work of the Bureau, and it is only proper and just that those who do it should be properly rewarded for their services. If they are not, the achievements of the Bureau suffer, either through the incompetence of those who are willing to remain at the inadequate salary, or through the continual turnover of clerical employees through a succession of persons being appointed to the same position, and leaving either because better opportunities are offered elsewhere, or because they have not the ability to perform the technical duties of the position they seek to fill.

## INSTRUMENT MAKERS.

In my 1918 annual report I summed up the situation in this Bureau with respect to the low entrance salary for instrument makers. The salaries that we were able to offer in normal times were not sufficient to attract men of the proper qualifications to make and repair our delicate and intricate surveying instruments. The men that do this work must be of a much higher class of attainment than are usually found in a quality-production instrument shop of even manufacturers of surveying instruments. Men in shops are generally skilled in only the production in numbers of special parts of a given instrument. Our instrument makers must be able to make parts and repairs to any of the delicate surveying instruments that we use, and with the highest degree of precision, because an inaccuracy in an instrument would bring inaccuracy in results from surveys made with it.

While the range of salaries that we were able to offer instrument makers in this Bureau during normal times was below the average, under present conditions, when wages and salaries have advanced so materially, the salaries in our lower grades have no attraction whatsoever for men who are in the least qualified to adjust, repair, and make our delicate instruments.

What we should have is a range of salaries that would not only invite men of the proper technical qualifications to come to us, but which would hold out prospects of advancement that would assure their remaining with the Bureau. We never get men of these qualifications. They are attracted to other shops, where the pay and opportunity are on a parity with their training and ability. And, yet, these are the men that we need. With a corps of such men instruments would be perfected that would far more than offset the additional wage scale that would be required to accomplish it. To attract men of this caliber would require an entrance salary of $1,600 or $1,800 per annum. I am reliably informed that these are the entrance salaries prevailing to-day in many branches of the Government service and many of the more technical industrial plants. In our relatively very low entrance salary of $1,200 per annum the positions are usually vacant because we can not induce suitable men to accept them or they are filled by temporary employees who can under no circumstances qualify for permanent appointment, but whose services can be used to some purpose, though sometimes they are of questionable advantage. Some of these authorized positions have been vacant for months at a time.

The chief of this important section is a mechanical engineer of rare skill and ability who receives the low salary of $2,750. I doubt if anyone near his caliber could be secured for more than twice what is provided by law. Regardless of the individual, the position justifies a salary of $3,600.

### NEED OF MODERN BUILDING.

The quarters occupied by this Bureau are a disgrace pure and simple. Insanitary and responsible for a clear loss of efficiency, I doubt if any other arm of the Government has to put up with such quarters. Easily remedied at a comparatively small cost, yet year after year appeals go for naught, while other bureaus enjoy modern and expensive buildings.

Year after year I have called attention to the need of a modern and adequate building to house this Bureau in place of the present makeshifts. We never can do efficient work in a building or buildings so unsuitable for our needs. It is physically impossible to bring together under proper supervision the different units of our organization. Where artisans, laborers, and employees of all kinds are scattered here and there in small rooms, under insanitary conditions, without proper light and proper ventilation, the best of results can not and ought not to be expected. So acute did this become during the war, and so essential was the product of this Bureau to the successful prosecution of the war, that on your presentation of our needs to the President, he authorized the use of funds placed at his disposal by Congress for the construction of a comparatively small building adjoining our present building to relieve the existing congestion. This building is now completed, and the facilities that it affords only emphasize the great drawback and handicap under which we are operating in our present old quarters. I think it proper for future reference to record here the kind of buildings we are now occupying and the history of their requirement.

This Bureau occupies a red brick building on New Jersey Avenue, southeast of the Capitol Building; two adjoining granite buildings, with three small brick buildings in the rear; and a new, hollow-tile, fireproof building to the south, all of which are connected by bridges.

The main or brick building was erected in 1871 by A. and T. A. Richards and in that year was rented for the use of the Coast and Geodetic Survey. Previously, from August 2, 1832, the service had been quartered in a building on New Jersey Avenue, south of the present site, erected by Thomas Law about the year 1800, and a house adjoining to the north. The latter was used as quarters by the Superintendent, as was afterwards a portion of the main building, from 1871 until 1873. A small brick structure, with iron doors and windows, near the corner of New Jersey Avenue and C Street SE., was used for storage of engraved plates and other valuable records and property of the service until 1874.

The Richards Building, together with a small brick structure for the use of the electrotype section and carpenter shop, and the land adjoining, was purchased by the Government for the Treasury Department, September 21, 1891, for the sum of $155,000, the site fronting east 199 feet 6 inches on New Jersey Avenue, west 199 feet on South Capitol Street, and being about 200 feet deep. The legislation authorizing the purchase of this property is contained in an act of Congress approved March 3, 1891. Since 1871 the buildings have been continuously occupied by the Coast and Geodetic Survey. They are provided with steam heat from two horizontal boilers, and are equipped with an electric freight elevator.

The three granite buildings, of which two are occupied by the Coast and Geodetic Survey, were erected by Gen. Benjamin F. Butler in 1873–74 and were constructed of granite from Cape Ann, Mass. The fireproof building adjoining the main building occupied by the Service, and which has been especially designed for its use, was used for the storage of valuable records, original maps, engraved plates, and documents from June 8, 1874.

This whole property, including the middle building and that fronting on B Street, was purchased by the Government for the use of the Treasury Department, April 10, 1891, from Benjamin F. Butler for the sum of $275,000, in pursuance of an act of Congress approved March 3, 1891. The land has a frontage of 119 feet 3 inches on B Street SE., 80 feet east on New Jersey Avenue, and 97 feet west on South Capitol Street. That portion fronting on B Street is now used by the United States Public Health Service, to which it was assigned by the Secretary of the Treasury in 1891. The two buildings to the south are used by the Coast and Geodetic Survey. The entire group of buildings is heated by steam from two horizontal boilers in the portion used by the Public Health Service. A brick structure to the rear, formerly a barn and annex, was also included with the property, and used by the Coast and Geodetic Survey to house its chart-printing presses.

In 1903 all of the above-described buildings then occupied by the Coast and Geodetic Survey were transferred with that Bureau to the then Department of Commerce and Labor, now Department of Commerce, in accordance with the act approved February 14, 1903, and with a provision contained in the deficiency act approved March 3, 1903.

In the sundry civil act of August 1, 1914, was appropriated $12,500 for an extension and rebuilding of the old brick building in the rear of the Butler Building for the use of the printing section of the Bureau, which had greatly overgrown the available space. By April 7, 1915, a one-story annex and a new three-story building had been erected in the space between the Richards and Butler Buildings. This filled a long-felt want, and greatly added to the facilities for printing charts.

Under dates of March 8 and June 17, 1918, the approval and authorization of the President were contained in allotments of $75,000 and $30,000, respectively, a total sum of $105,000, for providing the needed facilities for work of preparing charts, military maps, and other special work for the Army and Navy by the construction of a suitable building for this purpose.

On September 18, 1918, an additional allotment of $29,250 was made for the purpose of equipping the new building.

The allotments were made from the funds appropriated by Congress, and placed at the disposal of the President for national security and defense during the period of the war with Germany and Austria.

On June 28, the date of the approval of the bond incident to the construction of this building, the contract was awarded to Wills, Egelhof & Co., 161 Park Avenue, New York City, for the total amount of $94,860, and work was commenced upon the same date. The contract time for the completion of the work was six months from the date of acceptance, which expired on December 28, 1918, but at the close of the fiscal year ended June 30, 1919, the building was not ready for occupation. It was so nearly completed, however, that it was available soon after that date.

The building was erected upon the vacant lot to the south of the Richards Building, and occupied practically the entire lot with sufficient space all around for securing suitable light. It is of hollow-tile construction two stories in height, the upper for the use of the drafting section, and the lower for the instrument section, including machine and carpenter shops.

## DESCRIPTIONS OF BUILDINGS.

*Richards Building.*—The Richards Building consists of two parts, known as the front and back buildings, and these are connected by comparatively narrow passageways on each floor. The front building consists of six floors which, reckoning from the bottom, are occupied, respectively, by (1) part of the instrument section; (2) the section of tides and currents; (3) the office of the engineer in charge, disbursing agent, and mail clerks; (4) the division of geodesy; (5) the engraving section; and (6) the photograph gallery.

The back Richards Building consists of five floors and a basement, but on the eastern end of the roof a structure has been built to provide a room for photographic printing. The floors of this building are occupied, respectively, by (1) boiler room and storage rooms in the basement; (2) instrument machine shop and instrument storeroom; (3) the sales section; (4) the office of the chief of the division of charts and the main part of the drawing section; (5) the office of the Superintendent and the main part of the division of hydrography and topography; (6)parts of the drawing and engraving sections; and (7) photographic printing room.

Each floor of the back building is a half floor lower than the corresponding floor of the front building.

*Butler Building.*—The Butler Building was originally three separate and distinct buildings. The corner one is now occupied by the Public Health Service, and the other two by the Coast and Geodetic Survey. Those occupied by the Coast and Geodetic Survey are designated for convenience as the archives building and the library building, and they have communicating bridges on the first and third floors only. The Butler and Richards Buildings are also connected by bridges on the first and third floors. The first floors are on the same level, but the third floor of the Butler Building is about 2 feet higher than the corresponding floor of the Richards Building.

The archives building, with the exception of the third floor and basement, is used for the archives, the third floor being occupied by part of the engraving section, and the basement for the storing of proper engraving plates, and other miscellaneous material. The library building is occupied as follows: The basement, which is in two levels about 2½ feet apart, is used for the storage of aluminum plates and general storage; the first story is occupied by the library and reading room; the front of the second floor is used by field officers when on duty in Washington, and the rear by the miscellaneous section; the third floor by the division of terrestrial magnetism; and the fourth floor by field officers while temporarily assigned for duty at Washington.

*Printing buildings.*—These buildings are in the rear of the Butler Building, and partially between the Richards and Butler Buildings. The old three-story part directly in the rear of the Butler Building is occupied as follows: The lower floor or basement is used for dressing, toilet, or miscellaneous working rooms and storage; the second floor is used for the hydraulic paper press and the storing of paper used in chart printing; and the third floor is a lithographic drafting room. The new brick building between the old brick and the Richards and Butler Buildings is occupied as follows: First floor is the printing-press room; the second floor is used as an office, a transfer room, and a process-printing dark room.

*Carpenter shop.*—This old brick building, a part of the Richards property, and located to the south of the main building, is two stories in height, and since 1881 one-half of the lower floor has been used by the electrotype section, while the other half of this floor and the whole of the upper floor have been used as a carpenter shop.

*Chart, instrument, and archives building.*—At the close of the fiscal year 1919 this building was not ready for occupation. The lower floor is intended for the use of the instrument section, including the instrument and carpenter shops, while the upper floor is to be occupied by the drafting section of the division of charts.

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|---|---|
| Levels in buildings: | |
| Richards Building | 16 |
| Butler Building | 10 |
| Printing building | 7 |
| Carpenter shop | 3 |
| Chart, instrument, and archives building | 2 |
| Area of floor space of buildings: | |
| Total area of rooms | 52,863 |
| Eliminate areas not fit for office work— | |
| Cellar | 3,362 |
| Carpenter shop | 2,926 |
| Old printing building, basement | 2,200 |
| Butler Building, basement | 3,204 |
| | 11,692 |
| Total available area | 41,171 |
| Area of chart, instrument, and archives building | 15,200 |
| Total office space | 56,371 |
| Area of halls, stairways, etc | 12,678 |
| **Total area, including halls, etc** | **69,049** |

## HEAT AND LIGHT.

As has been mentioned in this report heretofore, the buildings occupied by this Bureau are heated by steam heat from four horizontal boilers, two of these boilers being located in the basement of the buildings occupied by the Public Health Service and two in the basement of the Richards Building. While one set of these boilers is located in the basement of the building occupied by the Public Health Service and provides heat for the building occupied by that bureau and part of the building occupied by this Bureau, firemen and stokers sufficient to operate both the boilers located in the basement of the building occupied by the Public Health Service and those in the basement of the building occupied by this Bureau are supplied and their services are paid for out of the appropriations for this Bureau. The coal consumed in the boilers in the basement of the building occupied by the Public Health Service is provided by that bureau and the coal consumed by the boilers in the basement of the building occupied by this Bureau is provided out of our appropriations.

As an emergency measure during the Spanish-American War a copper cable line for supplying electric current was run between the Capitol and the building occupied by this Bureau. This line supplied direct current. In view of the fact that a considerable amount of photographic work was done by this Bureau for the office of the Superintendent of the Capitol Building and Grounds during the Spanish-American War, and after that war terminated, a certain amount of electric current continued to be supplied from the Capitol over the lines that had been installed during the war. Out of this grew the fact that machinery and equipment were installed and operated by electric generators provided with motors for direct current. Electric current not used for operating machinery, but for electric lights, etc., was obtained by purchase from the Potomac Electric Light & Power Co. After the Spanish-American War had ceased, and the activities of this Bureau had so broadened that the amount of direct current that we were consuming and which was supplied from the Capitol Building was out of proportion to the photographic work and blue printing we were doing for the Superintendent of the Capitol Building and Grounds, and there was strictly no authority for supplying the current except as an emergency war measure, steps were taken to discontinue its use from that source and purchase all of the current needed by this Bureau from the Potomac Electric Light & Power Co. Inasmuch as it has thus come about that our electric equipment was suited for operation by direct current, and the Potomac Electric Light & Power Co. had theretofore been supplying the alternating current, negotiations were taken up with that company with the end in view of having the direct current supplied to this Bureau. The outcome of these negotiations was that the Potomac Electric Light & Power Co. was not able to run mains for supplying the direct current to this Bureau, and the only alternative was that either the machinery that was in operation in this Bureau to be run by direct current should be discarded and replaced by machinery to be run by the alternating current, or that a converter should be installed in the basement of this Bureau. After a thorough investigation it was determined that it would be more economical to install a dynamo for converting the alternating current supplied by the commercial power company into direct current than to discard the machinery operated by motors for direct current which were then in use. Such a dynamo was installed and is now in operation.

I have given this matter much thought, and it is obvious that there is no legal authority as the law now stands for supplying either heat or light by any other means than those employed at present. The fact remains, however, that a supply main for steam from the Capitol power plant passes directly through the buildings occupied by this Bureau, and that a dynamo for alternating current supplied from the central power plant is in operation in the basement of the House Office Building directly across New Jersey Avenue from this Bureau.

To the casual observer who is unacquainted with the legal limitations which prohibit our utilizing these sources of supply it is an apparent extravagance for us to purchase out of our appropriations from a commercial electric company, which purchase necessarily includes a profit to that company, the electric current used by this Bureau and to employ a force of dynamo tenders throughout a 24-hour day (three shifts of 8 hours each), to purchase coal, and hire firemen and stokers for operating our heating plant, when both light and heat can be supplied and are immediately available from a central power and heat plant maintained by the Government. While statistics are not available for determining the exact cost by a unit of measure of electric light and heat by the Capitol power and heating plant, based on the best available sources of information, I believe it is fair to say that the actual saving to the Government, if it were supplied from the Capitol power and heating plant, would be approximately $4,000 per annum. The most practical solution of the legal difficulty of supplying light and heat from this plant for the Coast and Geodetic Survey appears to me to be to have legislation effected authorizing that heat and light shall be supplied this Bureau from the Capitol power and heating plant, the amount to be determined as supplied by a unit of measure and paid for out of the appropriations for this Bureau. Practical experience has demonstrated the economy of supplying heat and light from a central producing plant rather than from many small units, and certainly very considerable economy would result from such a procedure if authorized.

## ROTATION OF FUNDS RECEIVED FROM THE SALE OF NAUTICAL CHARTS.

The present law provides that the charts published by this Bureau shall be sold at the cost of paper and printing as nearly as practicable. The funds that are expended in the purchase of chart paper, printer's ink, etc., are contained in the annual appropriations for this Bureau in the sundry civil bill under the subheading of "Office expenses." The appropriation under this subheading for the fiscal year for which this report is written was $80,000. Besides chart paper and printer's ink, out of this appropriation must be paid every expenditure incident to the maintenance of the headquarters of this Bureau at Washington, D. C., including the purchase of instruments for field work. Because of the varying costs of materials, etc., it is extremely difficult to make estimates with any degree of accuracy from year to year to meet the expenditures under this subitem in our appropriations. If prices advance materially, as they have in the past few years, the appropriation is entirely exhausted some months before the close of the fiscal year for which it is made. This results in a material deduction in our output. To overcome this difficulty in a measure I have this recommendation to make: That as our charts are sold the funds received from the sale thereof shall be placed to the credit of this Bureau in the Treasury to be again drawn upon for the purchase of chart paper, ink, etc. The advantage that would result would be that, if the sale of our charts is fluctuating, the receipts will fluctuate accordingly, and a fund will always be maintained for the production of charts, and we will not need to curtail our output because the appropriation has not been sufficient to meet our need for a given fiscal year. Heretofore we have frequently been compelled to submit deficiency estimates on this account, and the delay incident to placing funds at our disposal through a deficiency estimate has at times prevented our printing charts that are needed by the public.

# CHAPTER II.

## WORK OF THE WASHINGTON OFFICE.

The organization of the Washington office throughout the year by divisions and sections was, as in the previous year, with the exception that on April 1 the section of field records was transferred from the division of hydrography to the division of charts, and on May 1 the section of printing and sales was transferred from the division of hydrographic and geodetic engineer in charge of the office to the division of charts. Therefore the organization at the end of the fiscal year was as follows:

Division of hydrographic and geodetic engineer in charge of the office: Section of instruments, section of library and archives, and section of miscellaneous.

Division of geodesy.

Division of hydrography and topography: Section of field work, section of vessels and equipment, section of coast pilot, and section of tides and currents.

Division of charts: Section of field records, section of drafting, section of engraving, section of printing and sales, and section of photography.

Division of terrestrial magnetism.

Division of accounts.

The work done by the Washington office during the fiscal year, by divisions of the office, was as follows:

### DIVISION OF HYDROGRAPHIC AND GEODETIC ENGINEER IN CHARGE OF THE OFFICE.

The general duties of this division are: The care and upkeep of the buildings occupied by the Bureau; the designing and repairing of surveying instruments and equipment, and packing and shipping them to the field parties; the purchase of supplies for the office, for chart printing work, and for the field; the care and custody of the original records of field surveys as well as the library of printed publications kept for the use of the Bureau; the keeping of the records of leave of absence taken by the personnel of the Bureau; the custody and accounting for the receipts from the sales of charts and publications sold by the Bureau.

It would be tedious and serve no good purpose for me to give the minute details in carrying out the duties of the division of the hydrographic and geodetic engineer in charge of the office generally outlined above. It is sufficient for me to say that the work was done efficiently and satisfactorily, and I shall make mention only of some of the more important items and accomplishments.

The most important of these toward establishing facilities for the work of the Bureau during the year was the erection of the new building known as the chart, instrument, and archives building. This has supplied a long-felt want in furnishing a modern, thoroughly equipped machine shop, carpenter shop, and drafting room. The emergency requirements of the war threw a great burden upon the Coast and Geodetic Survey. Demands were made upon us for charts in unprecedented numbers by the Navy Department and by the Shipping Board. The war had not been long in progress before the demand for delicate instruments both on vessels of the Navy and for use in the Army became acute. In conjunction with the Bureau of Standards some of the most delicate navigational instruments used on board our vessels were designed. This brought about the need of more room for draftsmen and for instrument makers in this Bureau. On my presentation of these facts to you, you in turn brought them to the attention of the President, and under date of March 8 and June 17, 1918, he authorized allotments of $75,000 and $30,000, respectively, a total sum of $105,000, for providing needed facilities for the work of preparing charts, military maps, and other special work for the Army and Navy by the erection of a suitable building for that purpose. On September 18, 1918, an additional allotment of $29,250 was made for the purpose of equipping the building. These allotments were made from funds appropriated by Congress and placed at the disposal of the President for the national security and defense during the period of the war with Germany and Austria.

Another great improvement was the installation of a Harris offset automatic printing press, with a capacity of printing charts 34 by 48 inches at the rate of 3,500 per hour. This press, too, was purchased through an allotment of $14,000 made for the purpose by the President from the funds placed at his disposal by Congress for national security and defense during the war with Germany and Austria. At the time the allotment was made the Bureau was largely engaged in the printing of navigational charts absolutely necessary for the use of the Army and Navy, and realizing the resulting disaster in case of a breakdown of one of the other presses the purchase of this additional press was authorized.

On our representation to Congress of the great necessity funds were appropriated to the extent of $1,500 in the sundry civil act approved July 1, 1918, for the purchase of two motor-driven lathes for the instrument section of this Bureau. These have been purchased and installed, and by their use the work will be greatly facilitated.

A hot-water-storage system was installed in the boiler room of the Richards Building. This has made it possible to dispense with the two small, inefficient water heaters, one in the hallway of the Richards Building and one in the printing building, which had formerly been in use. The result is that we have an economical hot-water system which supplies hot water throughout all of the buildings. The cost was $1,625.

A new concrete floor was put into the dressing room of the printing building at a cost of $545. The floors in rooms 343, 347, 462, and 406, and a portion of the pressroom floor in the printing building, were covered with linoleum at a cost of $438.75.

A vestibule door was installed at the main entrance to the Richards Building at a cost of $230.

The official records kept by the hydrographic and geodetic engineer in charge of the office show that the total number of permanent and temporary employees in the office and field, which included all employees appointed through civil-service certification, were as follows:

| | |
|---|---|
| Office force | 218 |
| Field force | 229 |
| Total | 427 |

The above is in reference to classified employees. Persons employed in rodding, as chainmen, recorders, and heliotropers in the field parties, and enlisted men on vessels in the service are not enumerated, as the number is variable, depending upon the extent of activities in the field.

The statistics in regard to leaves of absence during the calendar year 1918 are as follows:

| | Days. |
|---|---|
| Annual leave | 6,927 |
| Sick leave | 2,429 |
| Leave without pay | 1,178 |
| Accrued leave | 1,062 |

While the number of employees naturally varies on account of resignations and vacancies, calculated on the number actually in the service on June 30, 1919, as a basis of computation, the average annual leave taken during the year by each employee was 19 days and the sick leave 5½ days.

Based on the official day of seven hours, the overtime performed by the employees of the office during the fiscal year amounted to 1,021 days or approximately 5 days for each employee.

The receipts from the sale of charts, publications, old property, etc., amounted to $25,466.65.

## DIVISION OF GEODESY.

The most important pieces of work which were completed during the past fiscal year or which were in progress during that time are the following:

Computation and adjustment of the following pieces of triangulation:

1. Primary triangulation, Atlanta-Griffin.
2. Rio Grande arc of primary triangulation.
3. In Rhode Island.
4. In Maryland.
5. In Massachusetts.
6. Vicinity of Macon, Ga.
7. Coast of New Jersey.
8. In Louisiana.
9. Mobile Bay, Ala.
10. Aberdeen Proving Grounds, Md.
11. Newport, Calif.
12. Eastern oblique arc to Sanford, N. C.
13. In New York.

The computation of the following lines of primary traverse:

1. Macon-Griffin, Ga.
2. Macon-Savannah, Ga.
3. Norfolk, Va.-Savannah, Ga.
4. Albany, Ga.-Callahan, Fla.
5. Brunswick-Columbus, Ga.
6. Savannah-Everett, Ga.
7. Jacksonville, Fla.-Columbus, Ga.
8. Wilmington-Sanford, N. C.

The computation and adjustment of the following lines of precise levels:

1. Biloxi, Miss.–River Junction, Fla.
2. Sinton, Tex.–New Orleans, La.
3. Memphis, Tenn.–Little Rock, Ark.
4. Harlingen–Eagle Pass, Tex.

## DIVISION OF HYDROGRAPHY AND TOPOGRAPHY.

The division of hydrography and topography has supervision of all hydrographic and topographic surveys executed by the Coast and Geodetic Survey, which supervision includes the determination of where surveys or resurveys are required, how they shall be conducted, the preparation of instructions for the surveying parties, the organization of the parties, and the inspection of the field work and examination of the field records that result from these surveys. This division is also charged with the construction, maintenance, and repairs of vessels and other field equipment, except instruments; the compilation of the coast pilot in the field and office; the observations of tides and currents; and compilation of tide tables. For administrative purposes the division is divided into four sections, known as the section of field work, section of vessels and equipment, section of coast pilot, and section of tides and currents. This division is also charged with the supervision of the five field stations of the Bureau. These stations are located at the following cities: Boston, Mass.; New York, N. Y.; New Orleans, La.; Seattle, Wash.; and San Francisco, Calif. Under the direction of this division there is also an office at Manila, P. I. The Manila office performs all of the functions of a field station and, in addition, has direct charge of all surveys in the Philippine Islands and much of the office work incident to these surveys.

Data were collected and itemized memoranda prepared for 23 sets of instructions for field work. This embraced a careful study of existing surveys. Original field sheets covering areas where changes frequently occur, and where preliminary surveys only have been made were reviewed in order to formulate plans for performing the necessary field work to bring the charts up to date. Completed field sheets were reviewed, as time permitted, preparatory to recommending them for the approval of the Superintendent.

During the year a coast pilot of the Philippine Islands was prepared. Also, reprints were obtained of coast pilots as well as for three volumes of coast pilots for California, Oregon, Washington, and one volume for Alaska.

The manuscript for the tide tables for 1920 was prepared and submitted for printing in three separate parts, namely, the Atlantic Coast Tide Tables, the Pacific Coast Tide Tables, and that part of the General Tide Tables which is not included in either of the two reprints. These tables are similar to those issued by the Bureau for the past two or three years.

## DIVISION OF CHARTS.

A fairly large proportion of the time of the chart division during approximately the first half of the fiscal year was devoted to war work. Charts, photographic enlargement, and reductions of charts and original surveys were furnished, projections made for laying out ranges, etc., drawing and photographic work for compass roses were made for the Navy, and a drawing water-colored and photographed for an aircraft flag for the Signal Corps. In addition to the above war work mentioned in general terms, the regular duties of the division accomplished were as follows:

Drawings were finished for 7 new and 7 old charts, making 14 complete chart drawings.

Ninety-one drawings of extensive chart corrections and 438 drawings for minor chart corrections were made.

One thousand five hundred and eighteen changes to the aids to navigation, including dangers, were charted and inserted in the standards filed for the printing and sales section for hand correction.

Two thousand four hundred and fifty-six proofs of charts were verified that were received for correction before reprinting.

Drawings for new charts or extensive corrections of Philippine Island charts, received from Manila, were prepared for printing.

Forty-two hydrographic sheets were completed in this section before this work was taken over by the field record section.

In cooperation with the Bureau of Lighthouses weekly Notices to Mariners were prepared and published. A large number of miscellaneous drawings, including illustrations for the annual report of the Bureau, publications of this and other bureaus of the Government, projections for field parties, etc., were made.

Approximately 50 plates in addition to new editions and bassos were corrected so that a transfer could be made for the new offset press. These corrections not only involved the necessary changes from recent data, but also included the corrections made by the lithographers on all new prints subsequent to the time of the last transfer. Sometimes these corrections for a single plate were scattered through a formidable amount of proof. It is evident that a printing plate brought up to date in this manner without error required close cooperation of the different sections and expert proof reading.

In view of the reduced drafting force, every effort has been made by the engraving section to relieve the draftsmen of some particular portion of the work heretofore done by them. At the present time a plate for Marsh, from which the symbol will be applied direct to the printing plate, is being engraved as an experiment and for eliminating handwork on drawings.

Several new charts which have been finished during the year or are still in hand, instead of being engraved from a drawing compiled by the draftsmen, have been engraved from transfer of negatives of reduced photographs of larger scale charts or transferred from a printing plate of the same scale. Also proofs which were formerly verified in the drafting section have been verified by engravers, so that only the final proofs have been verified by the draftsmen.

Barring 1917, when the then new lithographs were printed for the most part in black and white only, the number of charts printed was the largest in the history of the Bureau. Issue and condemnation has passed the 300,000 mark. The increase over 1918 was 28 per cent. It was 136 per cent greater than for the year 1915. The United States Shipping Board is becoming a real factor, having used 21,707 charts in 1919, as compared with 10,657 in 1918.

The graphic diagrams opposite show the issue of charts from 1888 to 1919, inclusive, and the issue of coast pilots for the same period.

## DIVISION OF TERRESTRIAL MAGNETISM.

The war work of the division was confined to the supplying of magnetic data to various Army camps and organizations, and to persons engaged on investigation of the submarine problem.

The results of the field work executed during 1918 were computed and prepared for publication.

The reduction of the work of the five magnetic observatories for 1917 was practically completed, and that for 1918 was well advanced. Further progress was made in the reduction of the work of the San Antonio Observatory, 1890–1895.

The earthquakes recorded at the five magnetic observatories have been tabulated monthly, and the results have been published in the Monthly Weather Bureau Review, and transmitted to the International Seismological Association and others engaged in a comparative study of earthquake data.

The results of magnetic observations in Alaska to the end of 1918 were tabulated, the secular change data were collected, and tables prepared for reducing the results to 1920; this reduction was made, and preliminary isogonic lines were drawn for that epoch.

The results of observations made at the time of the solar eclipse of June 8, 1918, were prepared for publication in the Journal of Terrestrial Magnetism.

Data concerning preliminary impulses of 17 selected magnetic storms were prepared for De Moidrey, including tracings of portions of the magnetograms from the Cheltenham, Tucson, Honolulu, and Sitka observatories.

A paper on the relation between seismic and magnetic disturbances was prepared for publication in the Bulletin of the Seismological Society of America at the request of the editor.

A table giving the values of the magnetic declination at numerous places in the United States for 1920 was prepared for insertion in the World Almanac.

A new edition of Principal Facts of the Earth's Magnetism was submitted for publication, the supply of the last edition being very nearly exhausted.

Compass data were supplied for 126 charts.

## PUBLICATIONS ISSUED DURING THE YEAR.

Serial No. 74. Triangulation in Maine. By Walter F. Reynolds, chief computer, division of geodesy. U. S. Coast and Geodetic Survey. Special Publication No. 46, 286 pp. 22 figs. Octavo.

Gives results of triangulation in Maine by the U. S. Coast and Geodetic Survey.

Serial No. 80. Atlantic Coast Tide Tables from Eastern North America for the year 1919. 222 pp. 13 figs. Octavo.

Gives tidal data and other information useful to mariners for the principal ports on the eastern Atlantic coast for the year 1919.

Serial No. 83. Pacific Coast Tide Tables for 1919. 192 pp. Octavo. (Reprinted from the General Tide Tables.)

Gives tidal data and other information useful to mariners for the principal ports on the Pacific coast for the year 1919.

Serial No. 91. United States Coast Pilot, Section B; Cape Cod to Sandy Hook. 326 pp. 2 figs. Octavo. Price, 50 cents.

This volume covers part of the territory formerly included in Atlantic Coast Pilot, Part III, and all of the territory formerly included in Atlantic Coast Pilot, Part IV.

Serial No. 92. General Theory of the Lambert Conformal Conic Projection. By O. S. Adams. Special Publication No. 53. 38 pp. 11 figs. 12mo.

This publication contains a general development of the Lambert conformal conic projection. It supplements Special Publications Nos. 47, 49, and 52, since it gives as a whole the mathematical development of the theory upon which they depend.

Serial No. 94. Results of Observations Made at the U. S. Coast and Geodetic Survey Magnetic Observatory at Cheltenham, Md., 1915 and 1916. 112 pp. 21 figs. Quarto.

This is one of the regular series of publications giving results of observations made at the magnetic observatories maintained by the U. S. Coast and Geodetic Survey.

Serial No. 95. General Tide Tables for the Year 1919. 487 pp. 12 figs. Octavo. Price, 50 cents.

Gives tidal data for the principal seaports of the United States and for many foreign ports.

Serial No. 96. Supplement to the United States Coast Pilot, Atlantic Coast, Section D; Cape Henry to Key West, May 24, 1918. 25 leaves. Octavo.

Gives latest corrections in sailing directions, aids to navigation, etc., for that volume of the Atlantic Coast Pilot.

Serial No. 97. Report of the Connection of the Arcs of Primary Triangulation Along the Ninety-eighth Meridian in the United States and in Mexico and on Triangulation in Southern Texas. Special Publication No. 54. 1919. 93 pp. 17 figs. Octavo.

Gives geographic positions and descriptions of stations in the primary triangulation along the ninety-eighth meridian in the United States and in Mexico and of triangulation in southern Texas.

Serial No. 99. United States Coast Pilot, Atlantic Coast, Section A; St. Croix River to Cape Cod, 1918. 305 pp. Octavo. Price, 50 cents.

This publication covers all of the territory formerly included in Atlantic Coast Pilot, Parts I, II, St. Croix River to Cape Ann, and a part of the territory formerly included in the Atlantic Coast Pilot, Part III, Cape Ann to Point Judith, of which three editions each were published.

Serial No. 101. Regulations for the Government of the U. S. Coast and Geodetic Survey. 167 pp. Octavo.

Contains the revised regulations adopted by the Department of Commerce for the government of the U. S. Coast and Geodetic Survey.

Serial No. 102. Uniform Regulations for the Field Corps of the U. S. Coast and Geodetic Survey, 1918. 16 pp. 5 plates. Octavo.

Gives description, specifications, and cuts of the uniforms prescribed for officers and men of the U. S. Coast and Geodetic Survey.

Serial No. 103. Atlantic Coast Tide Tables for 1920. 6 figs. Octavo. Price, 10 cents.

Gives times and heights of high and low water for principal ports on the Atlantic coast for the calendar year 1920, and other information useful to mariners, including current tables and diagrams; times of sunrise and sunset, and moonrise and moonset; and tables of differences by means of which tidal data may be obtained for other ports not mentioned in the tables.

Serial No. 105. Results of Magnetic Observations Made by the U. S. Coast and Geodetic Survey in 1918. 82 pp. Octavo.

Gives results of magnetic observations at the magnetic observatories and in the field in 1918.

Serial No. 106. Supplement to U. S. Coast and Geodetic Survey Catalogue of Charts, Coast Pilots, and Tide Tables, 1918. 5 pp. Quarto. 1919.

Gives corrections to the list of published charts, coast pilots, and tide tables to January 4, 1919.

Serial No. 107. Special Publication No. 56. Construction and Operation of the Wire Drag. 40 pp. 13 figs. Octavo. Price, 10 cents.

Explains briefly the construction and operation of the wire drag, the outfit and organization required, the kind of boats needed, methods of plotting the work, speed, area covered, and cost.

Serial No. 109. Important publications of the U. S. Coast and Geodetic Survey Appearing Since January 1, 1914. 6 pp. Octavo.

Contains a list of the more important publications issued since the date mentioned.

Serial No. 114. Supplement to U. S. Coast and Geodetic Survey Catalogue of Charts, Coast Pilots, and Tide Tables, 1918. (June 1, 1919.) 6 pp. Quarto.

Gives list of new charts; new maps; canceled, suspended, and reissued charts and coast pilots, and supplements; new editions of charts; and errata to last edition of catalogue published in 1918.

Annual Report of the Superintendent, Coast and Geodetic Survey. 1918. 133 pp. 37 figs. Octavo.

Gives an account of the field and office work accomplished by the Survey during the year, and a statement of the most urgent needs of the Bureau. The war activities of the Survey are briefly summarized.

Catalogue of Charts, Sailing Directions, and Tide Tables of the Philippine Islands (reprinted from the General Catalogue). 1918. 46 pp. 23 figs. Quarto.

This is a separate list published for the use of those who are chiefly interested in the publications relating to the Philippine Islands.

Philippine Island Sailing Directions, Sections VI and VII. Mindoro Strait, Palawan Island, and Sulu Sea and Archipelago Bulletin, Coast and Geodetic Survey, Manila, 1918. 290 pp. Octavo.

Gives sailing directions and information for the use of navigators in regard to aids to navigation, dangers, port facilities, etc., for the locations named.

Notices to Mariners. Issued weekly, jointly with the U. S. Bureau of Lighthouses, Nos. 1–52.

Philippine Islands Notices to Mariners, Nos. 2, 3, and 4 of 1918, and No. 1 of 1919.

Coast and Geodetic Survey Bulletin, issued monthly. July, 1918, to June, 1919, inclusive.

Supplement to Catalogue of Charts, Coast Pilots, and Tide Tables, July 10, 1918. 4 pp. Quarto.

Contains list of new charts, new editions of charts, canceled editions of charts, etc., since the last published edition of the catalogue.

### NEW CHARTS.

No. 219. North Shore of Long Island Sound, Milford to Stratford, Including Housatonic River, Conn. Scale 1:20,000. Price, 50 cents.

This new chart replaces the larger scale charts Nos. 263 and 264, and by the arrangement of its limits, shows on a larger scale than heretofore the Housatonic River from Long Island Sound to Derby.

No. 337. Lynn Harbor and Approaches, Mass. Scale, 1:40,000. Dimensions, 13 by 17 inches. Price, 20 cents.

No. 1117. Galveston to the Rio Grande. Scale, 1:400,000. Price, 50 cents.

No. 1269. Lakes Ponchartrain and Maurepas, La. Scale, 1:80,000. Dimensions, 30 by 42 inches. Price, 50 cents.

This chart supersedes chart No. 192, having the same descriptive title. It includes New Orleans and a portion of the Mississippi River from Mile Point to Lake Borgne Canal. This extension beyond the southern limit of the old chart shows, in a comprehensive manner, the relation of these lakes to the city and the exit to the Gulf by the river route.

No. 4336. Anchorages in Cuyo Islands, P. I. Cuyo Anchorage and Bisúcay Channel, scale 1:10,000; Taganayan Islands, scale 1:10,000. Price, 50 cents.

No. 4350. Western Entrance to Coron Bay, Calamian Group, P. I. Scale, 1:50,000. Price, 40 cents.

This new chart shows the western approach from the China Sea to Coron Bay and, with its companion chart No. 4351, gives a representation on a large scale of the thoroughfare between Busuanga and Culion Islands.

No. 6102. Approaches to Strait of Juan de Fuca; Destruction Island to Amphitrite Point. Scale, 1:200,000. Price, 50 cents.

No. 6447. Lake Washington Ship Canal, Puget Sound to Lake Washington, Wash. Scale, 1:10,000. Price, 50 cents.

This is the first published chart of this important recently completed waterway.

No. 8164. Steamer Bay, Wrangell Harbor, and Highfield Anchorage, Alaska. Steamer Bay, scale 1:20,000; Wrangell Harbor and Highfield Anchorage, scale, 1:10,000. Price, 30 cents.

Besides the new charts above listed, 66 new editions of charts were issued, some of which embody important corrections, additions, and new information.

While the foregoing is a complete list of the publications issued by this Bureau during the fiscal year, publications on two subjects have been issued by this Bureau that are of special importance. One of these is the series of publications on the Lambert Conformal Conic Projection. The principal of the Lambert projection is, in a measure, graphically illustrated in the figure opposite.

Many methods of projection have been designed to solve the difficult problems of representing a spherical surface on a plane. As different projections have unquestionable merits, as well as equally serious defects, any region to be mapped should be made the subject of special study, and that system of projection adopted which will give the best results for the area and purposes under consideration.

The Mercator projection, almost universally used for nautical charts, is responsible for many false impressions of the relative size of countries differing in latitude. The polyconic projection, widely used and well adapted for most topographic and hydrographic surveys, when used for the whole of the United States in one map, has the serious defect of unduly exaggerating the areas on its eastern and western limits.

Along the Pacific coast and in Maine the error in scale is as much as 6½ per cent, while at New York it reaches 4¼ per cent.

The value of the new outline map on the new Lambert projection can best be realized when it is stated that, throughout the larger and most important parts of the United States—that is, between latitudes 30½° and 49°—the maximum scale error is only one-half of 1 per cent. This amount of scale error of one-half of 1 per cent is frequently less than the distortion due to the method of printing and to changes in the humidity of the air. Only in southernmost Florida and Texas does this projection attain its maximum error of 2½ per cent.

The Lambert projection is well adapted to large areas of predominating east and west dimensions, as the United States, where the distance across from east to west is one and four-fifths times that of the distance north and south.

The strength of the polyconic projection, on the other hand, is along its central meridian. The merit and defects of the two systems of projection may be stated in a general way as being at right angles with each other.

Special features of the Lambert projection that are not found in the polyconic may be stated briefly as follows:

1. The Lambert projection is conformal; that is, all angles between intersecting lines or curves are preserved, and for any point (or restricted locality) the ratio of the length of a linear element on the earth's surface to the length on the corresponding map element is constant for all azimuths or directions in which the element may be taken.

2. The meridians are straight lines and the parallels are concentric circles.

3. It has two axes of strength instead of one, the standard parallels of the map of the United States being latitude 33° and 45°, and upon these parallels the scale is absolutely true. The scale for any other part of the map, or any parallel, can be obtained from tables contained in one of this series of publications. By means of these tables the very small scale errors in this projection can be entirely eliminated.

The other of these publications is the Report on the Connection of the Arcs of Primary Triangulation Along the Ninety-Eighth Meridian in the United States and in Mexico, and on Triangulation in Southern Texas. An event of great importance in the history of geodesy was consummated in the spring of 1916, when observations were made at stations on the northern and southern banks of the Rio Grande, which connected the arcs of primary triangulation which had been established in the United States and in Mexico along the ninety-eighth meridian. The connection is interesting to the geodesist, because it makes available a very long meridional arc of connected and completed triangulation.

This connection will make available data from which to compute with greater accuracy than heretofore the dimensions of the earth. This will in itself make the work a notable contribution to science. But of even greater moment is the fact that the connection of the triangulation of the United States and Mexico will enable the latter country to extend to new areas from the ninety-eighth meridian arc geodetic control for surveys and maps in the form of triangulation which can be made on the North American datum.

This datum had been called the United States standard datum previous to the year 1913, when it was also adopted by Mexico and Canada for their geodetic coordinates. Its designation was changed to the North American datum when it had thus attained an international character.

# Part II.—FIELD WORK AND NEEDS OF THE FIELD SERVICE.

## CHAPTER I.

## STATEMENT OF NEEDS OF THE BUREAU TO BETTER ACCOMPLISH ITS FIELD WORK.

### SURVEYING VESSELS.

Again my appeal that the failure to provide modern vessels for our hydrographic work is prolonging inefficiency, increasing cost for what is being produced, and, worst of all, the delay in protecting our waters against loss of life and property.

The end of the fiscal year finds us with a fleet of 15 vessels, a truly considerable number based on a comparison with those available in previous years, and probably more than has ever been at the disposal of the Bureau at any one time in its history. The comparatively large number of vessels at our command at the present time is due to the fact that 5 vessels have been transferred to the Coast and Geodetic Survey from the Navy Department under authority of the Executive order of May 24, 1919. These 5 were part of a number of vessels that the Navy Department found on its hands at the close of the war with Germany, and which had been acquired to meet the temporary naval need for patrol boats, etc. But, with our fleet augmented as it is by these additions from the Navy Department, we have not at all a satisfactory condition. While we have numbers, we have distinct *inefficient* units. When we learned that the Navy had spare vessels that were authorized to be transferred by the act of May 20, 1918, a board of Coast and Geodetic Survey officers was appointed by me to get in touch with the proper officials of the Navy Department and learn what vessels were available for transfer that were best suited for our needs. After a thorough examination of all the vessels that the Navy Department had available for transfer, the board recommended that we take over the 5 vessels from the Navy Department that have been named earlier in this report, and there are 2 other vessels of the Navy Department, probably, that will eventually come to us. These vessels were accepted, not because they were suited for our work, but because they are the best means to an end at the present time. I feel that we have a great responsibility in meeting the marine needs of this country in finding and charting the dangers to navigation. The need is so pressing that I believe that we are justified in doing what we can with these vessels from the Navy Department, though at a considerable excessive expenditure of overhead cost to accomplish the same results that would be brought about much more cheaply if we had vessels that are designed for our work.

While the Navy had a great number and variety of vessels at the close of the war that could be transferred to other services, and without close reflection, it might be assumed that certainly out of these numbers vessels could be selected that would readily meet our needs, and while the board I appointed canvassed the situation thoroughly, and made the best possible selection, the vessels we have thus acquired can not be efficiently operated as surveying vessels. The reasons are these: We can not economically carry on ship hydrography with a vessel that is too large, because she requires too large a complement of officers and men, nor can the work be done with safety with a vessel that is too small, because she can not live through the severe weather that will be met. Furthermore, the character of the area to be surveyed seldom permits clean-cut classification, so that it can be determined beforehand that such and such a portion of it will be done by vessel, and such and such a portion by launches. Therefore, greater progress is made, and more economically, if a vessel is equipped to carry launches on her deck, and when the field of operation is reached the launch hydrography (in waters too shallow for the vessel to operate) is done in conjunction with the ship hydrography. Thus the entire area is covered by the same party during the same season. These combined operations are carried on much more cheaply than if undertaken separately. To meet this condition, a vessel must be large enough to carry three or four heavy launches on her deck. For these reasons our selection of vessels from those available had to be confined to those of a tonnage of 200 to 1,000 tons. The vessels of such tonnage of those available from the Navy Department were yachts.

There are two classes of ship hydrography: Offshore, such as that off the coasts of California, Oregon, and Washington, out to the 1,000-fathom curve; the other class is known as combined hydrography, such as that along the coast of Alaska, where there are many areas of which the deeper water hydrography must be done by a vessel and the waters inshore by launches.

The particular reasons why the yachts that we have obtained from the Navy Department are not suitable for either of these classes of hydrography are these: The offshore hydrography that must be done by ships along the coast of Washington, Oregon, and California out to the 1,000-fathom curve, extends a general average distance of 30 miles from shore. Along these coasts the harbors of refuge are few and far between. Furthermore, the storms encountered within the area that must be surveyed are generally very severe. To buffet the storms that will surely be encountered, a stanch seagoing vessel is required. The yachts that we have acquired have neither the strength required of hull or machinery to stand the strain to which they would be subjected in these storms. Furthermore, if they were stanch enough for this outside work, they have not the fuel capacity to make it economical to operate them there. Too much time would have to be expended in running to the widely separated ports to obtain fuel supplies. This class of hydrography is done by running lines of soundings at right angles to the shore, to and from the shore, out to the 1,000-fathom curve. If a vessel only has fuel capacity to enable her to make but a few of these 50 or 60 mile trips from the shore out to the 1,000-fathom curve and back to shore, and then must abandon her work, and steam some hundreds of miles to a port to obtain a fresh supply of fuel, it is readily seen that there is an enormous loss of time, and, consequently, a great overhead cost to carry on this class of surveys with such a vessel. Vessels properly designed for this work are oil-burning, and have a cruising radius of several thousand miles. These are the reasons why these yachts are neither safe nor economical for executing offshore hydrography.

In respect to the combined operations—that is, areas where, for the sake of economy, the ship hydrography and the launch hydrography should be executed at the same time—there is this difficulty in undertaking it with the vessels that we have acquired from the Navy Department. The vessels that came to us from the Navy Department are yachts, and were used as patrol boats in searching for submarines. They are, therefore, built for speed, and along narrow lines. Consequently they have neither the deck room for the storage of launches, nor the stability to carry them. Neither have they the deck for installation of hoisting apparatus for hoisting the launch aboard the vessel. If the necessary three or four launches for use in combined operations were installed on the deck of one of these yachts, she would be so top-heavy that it would be hazardous to put to sea with her. Such a vessel would have to be at sea a considerable portion of the time effectively to carry on surveying operations.

The impression has gotten abroad that there is no justification in our asking for appropriations for new vessels especially designed for the work of this Bureau, so long as there would be surplus vessels after the war, but such views are erroneous. A great public need would be more quickly met, and in the long run dollars that come from the public treasury would be saved, if proper surveying vessels were provided for this Bureau. *It costs practically as much in personnel, food, and supplies to operate an inefficient vessel as it does to operate an efficient one.* As it is, we will make what progress we can at a very considerable loss of efficiency, in picking here and there sheltered waters where these vessels can be used, and equip the larger ones with as many launches as they will carry, probably not more than two, so that the vessel hydrography will progress more rapidly than the launch hydrography, and delays will be enforced in regions where combined vessel and launch hydrography are necessary. There is as much necessity for vessels of special design for making surveys as there is for use as tugs, ferries, lightships, and for freight or passenger vessels.

The course that legislation has taken in respect to providing new surveying vessels for this Bureau has largely prompted us to make the experiment of transferring to this Bureau the spare vessels of the Navy Department, and undertaking to make surveys with them. In 16 years, or from 1903 to 1919, but one effective appropriation was made for vessels for the Coast and Geodetic Survey, and that was for the fiscal year ended June 30, 1916, when the sum of $289,000 was authorized for two new vessels, including their equipment. Through this appropriation we procured two vessels, one especially designed and built for a surveying vessel and the other was purchased. For the fiscal year ended June 30, 1919, an appropriation was made in the following words, "for one new vessel, including equipment, to cost not exceeding $354,000, $50,000." On my submission to you, the question was presented to the Comptroller of the Treasury as to whether there was authority to enter into a contract for the construction of a vessel to cost not exceeding the limit mentioned. The Comptroller held that the legislation did not in specific terms declare that a contract could be executed in excess of the amount appropriated, and, therefore, such a contract would be in violation of the act of June 30, 1906, which provides that "no Act of Congress hereafter passed shall be construed to make an appropriation out of the Treasury of the United States or to authorize the execution of a contract involving the payment of money in excess of appropriations made by law, unless such act shall in specific terms declare an appropriation to be made or that a contract may be executed."

Prior to the late war, under our system of finance, the greater part of the revenue of the Government was derived from the duties paid by our commerce, and the demand that a small portion of the immense wealth, which is thus annually poured into the Treasury, should, for a few years, be expended in protecting the lives and property of those thus contributing, is so plainly just as to need no argument in its support. Conditions have been so abnormal since 1914, and international trade has been so hampered that statistics since that time are not representative. The actual receipts from customs in the Treasury, for the fiscal year ending June 30, 1913, were $312,509,946. For that same fiscal year the appropriations for making hydrographic surveys by the Coast and Geodetic Survey were $261,400, and no appropriation was made granting a vessel for this Bureau. We have not during the past years had the vessels and personnel to bring the surveys of our waters up to a proper standard. The charts of Alaskan waters are entirely incomplete, and the information shown on many of them is from exploration surveys by the Russians before Alaska was acquired by the United States, and with a lack of exactness that would not be tolerated at the present time. The charts of the waters of the three Pacific Coast States do not contain sufficient information for offshore navigation, and many of the charts of the Atlantic coast and Gulf coast of the United States are lacking in the same respect. This should be borne in mind, that heretofore the vessels that plied our waters have been largely of foreign registration, and therefore, losses on account of inadequate surveys have been borne to a considerable extent by other countries than ours, but that the war has brought about a great stimulation of shipbuilding in this country, so that our vessels have increased from 26,397 with a gross tonnage of 8,871,037 in 1917, to 27,217 with a gross tonnage of 11,261,444 at the beginning of the year 1919. What is more significant still is that the increase of our merchant fleet has been, not in small shore-hugging craft, but ships of a size and type adapted to ocean service. While on July 30, 1914, just before the outbreak of the great war, our seagoing merchant ships of 1,000 gross tons or over numbered only 755, of 2,128,731 gross tons. these vessels of more than 1,000 gross tons numbered on June 30, 1918, no fewer than 2,058, of 7,300,022 gross tons, or a net gain of more than 5,000,000 tons in vessels capable of ocean navigation.

## WIRE-DRAG LAUNCHES.

In the sundry civil bill for the fiscal year ended June 30, 1919, the sum of $62,500 was appropriated for wire-drag launches, including their equipment, for the Coast and Geodetic Survey. Out of this appropriation four 60-foot launches have been built and equipped and three 30-foot tenders. One 30-foot tender was purchased.

*While these launches have been in commission but a very short time, they have already demonstrated their efficiency in carrying on our wire-drag surveys.* They are trim vessels with sufficient strength to propel the wire drags, yet economical of fuel consumption. They are especially designed for this class of work, and, therefore, have the proper amount of space, and in right place for storing all the necessary equipment and implements for making wire-drag surveys. They are far superior to the weaker, lumbering fishing vessels that have been hired heretofore for pulling the wire drag, and which we have been forced to alter in order to install the wire-drag equipment, reels, engine, etc. With this demonstrated efficiency and economy that has resulted from the use of these vessels especially designed for this work, there is the stronger reason that such vessels should be utilized for carrying on all our wire-drag surveys. The wire-drag vessels that have been built for us out of the appropriation for 1919 are sufficient to operate two wire-drag parties. There are four regions where the wire-drag survey only is capable of finding the hidden, underwater dangers to navigation, and these are all along the coast of New England, Long Island Sound down to the entrance to New York Harbor. In this region are found the glacial deposits of bowlders that have been left beneath the waters bordering the coast. The second general region is the coast of Florida from Palm Beach southward around the southern shores and up to the neighborhood of Cedar Keys. In these waters the coral reefs are the dangers to navigation. Some of these reefs are in the form of small islands, known locally as keys, while others are entirely submerged, and therefore hidden from sight where they are grave menaces to navigation. While coral reefs are characteristic of all these waters, the regions where wire-drag examinations are most urgently needed are in the vicinity of Key West, and to the westward from there, and then northward through the channels that commercial vessels take in and out of the Gulf from Mobile, New Orleans, etc. The third region where wire-drag surveys are required is in the coral-infested waters of the Porto Rican and Virgin Islands. The fourth general region where wire-drag surveys are required is along the coast, and through the passages of southeastern Alaska. The danger to be found here by the wire drag is the pinnacle rock which is found in the form of a narrow needle-like rock that extends from a very great depth to very near the surface of the ocean. Ordinary soundings with the lead and line are of little avail in finding these pinnacle rocks, and indeed, are often quite deceptive in that such soundings show a very considerable depth, and give assurance of safety, while danger may be at hand. Instances are known where the pinnacle rocks come to within a very short distance of the surface of the water, while soundings showed depths of hundreds of feet in their immediate neighborhood. There is one other small area where the wire drag should be used, though of no considerable extent. This is at the Atlantic entrance to the Panama Canal.

Below is a summary of the wire-drag surveys yet to be made:

| Coast of— | Square statute miles. |
|---|---|
| New England | 1,344 |
| Florida | 500 |
| Porto Rico | 2,300 |
| Alaska | 49,975 |
| Entrance to the Canal Zone | 200 |
| Total | 54,319 |

From this it follows that two wire-drag parties that can be operated with the modern wire-drag vessels that we now have at our command, and which were built out of the money appropriated for the purpose in the sundry civil bill for 1919, can accomplish only a fractional part of the wire-drag work that remains to be done. In the belief that the remedy should be applied where the danger is greatest, one of these parties is operating in Long Island Sound and the other off the coast of Maine. Wire-drag work can be effectively carried on in these waters from about the first of April until the close of November. Climatic conditions do not permit the work being carried on during the remainder of the year. We have seriously considered sending these launches to Florida waters for operations during the winter season, and while there would be some gain, there are corresponding losses that we think would more than offset the gain. The main reasons are these: It is a long and somewhat hazardous run for such small vessels from the coast of New England to the coast of Florida. The wear and tear on the engines in making this run twice a year would be very considerable, so much so, that it is believed that it would materially shorten the life of the launches. Past experience has demonstrated that it is economical to give the wire-drag apparatus a thorough overhauling after each season of operation, rather than to continue it in service until a break occurs, which halts the whole party for a considerable time to make a minor repair; and if the equipment is continued in operation too long the minor breaks are very frequent. Practical experience has taught that much more is gained to go into the field with first-class equipment, and work the party to the limit of endurance during the season, disband the party, and place the vessels and equipment under the charge of a drag master during the winter months, and hold him responsible for a thorough overhauling of the equipment.

We have acquired from the Navy two fairly large power launches. While these have not been designed and built for wire-drag purposes, we believe that with some alteration they will fairly answer for this purpose. These will be used in Alaskan waters. The wire drag requires two power launches, one at each end of the drag. The launches that we have acquired from the Navy are larger than those that were built for us out of the appropriation for 1919. They are too large to be used both on the same drag. A very efficient drag would be formed by using one of these launches acquired from the Navy and one of the type of those that have been built for us out of the appropriations for 1919. Therefore, what we really need are four additional 60-foot launches of the type of those built out of the appropriation for 1919. Two of these in conjunction with the two launches which we have acquired from the Navy would make up two wire-drag parties for the Alaskan waters, and the other two would provide a wire-drag party for the coast of Florida. There is more wire-drag work than can be completed by the five wire-drag parties that would be thus provided within the lifetime of the launches. That is to say, that the period during which one of these launches can be operated in which the expense of maintenance and repair does not become too excessive is, probably, 10 years. After that time the upkeep would be excessive. The wire-drag work remaining to be done is so extensive that it would not be accomplished by five parties in 10 years.

## INCREASED APPROPRIATIONS FOR CONTINUING GEODETIC OPERATIONS.

Later in this report is given a statement of the progress of the geodetic survey of the United States and possessions. Therein the statement is made that primary triangulation has been executed to the extent of 14,000 miles, primary traverse to the extent of 2,000 miles, and precise leveling to the amount of 41,000 miles. The location of this geodetic work in the United States is graphically shown on a base map of the United States in another portion of this report. (See fig. 31.[a]) I have also stated earlier in the report that it is our ultimate aim to extend this work so that triangulation and precise leveling bench marks shall be placed within 50 miles of each place in the United States. It needs no argument to convince the practical civil engineer of the necessity of extending this work to this degree of completeness at the earliest possible date. Indeed, he will contend that it has now been far too long delayed. But, as this matter is finally of interest to all, as well as to civil engineers, I feel it proper here to make some explanation of its needs.

Geodetic control brought about by triangulation and precise leveling forms the basic framework on which all our maps of any accuracy are based. If the reader, without preliminary measurements, will draw on a piece of paper a floor plan of his residence showing the various rooms, the chances are that it will be to some extent out of proportion—that is, that all of the lines shown in the diagram thus drawn will not be true to scale. On the other hand, if the reader had measured each of the floor spaces in the floor plan of his residence, including the thickness of walls, and determined on a scale for his drawing, say, 10 feet of floor space to be represented by 1 inch of his drawing, and laid out his drawing in exact accordance with his measurement, his diagram would then be in exact proportion—that is, 1 inch measured on the diagram would always represent 10 feet by actual measurements on the floor plan of his residence. This is an illustration of the application of geodetic control in drawing maps. The area to be mapped is first triangulated through triangulation observations covering the area to be mapped, the same results are obtained as if distances between points were actually measured. With the distances between definitely marked points on the earth's surface thus known and determined, maps can be drawn true to scale. I would, therefore, urge that the main control be extended as rapidly as our equipment and personnel will permit, and that it should be completed within five or six years. To do this will cost about $1,000,000, and I would urge that one-fifth of that amount be appropriated each year, or about $200,000 per annum. Triangulation stations and precise leveling bench marks within 50 miles of each place in the United States is what this scheme contemplates. This is far from what the final necessity will require, and by no means reaches the degree of completeness of many of the foreign countries.

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[a] Not included in this compilation.

The Corps of Engineers, United States Army has, as one of its functions, the preparation of special military maps for the defense of the country and for other purposes. Most of the maps made for that organization will be close to the seacoast of the country. The control that will be used on those maps will be largely tertiary triangulation along the coast, done by the Coast and Geodetic Survey. That triangulation is, in some cases, in bad shape, due to the loss of station marks from the erosion of the shores and the work of man. It is, therefore, desirable that parties be sent along all the coasts of the United States to make inspection of the triangulation data. It is believed that, at least once in 10 years, triangulation stations should be visited and supplemented where necessary. During such an inspection the positions of any new permanent objects that can be used in surveying or by the navigator should be determined.

In addition to the use of these branches of surveying for mapping purposes they have a very great value in furnishing the definite geographic location of boundary monuments of the States and between adjacent countries. For this use alone the expenditure would be thoroughly justified, as litigation over State and county boundaries has cost the Nation millions of dollars in the past, and will continue to do so as long as boundaries are uncertain in position.

### INCREASED PAY FOR COMMISSIONED OFFICERS.

The pay for the commissioned officers in this Bureau must be increased if we are to retain a corps of experienced and competent men. Under our present scale of salaries the younger and more efficient men are leaving us for better opportunities elsewhere. Within 7 months 11 of our junior hydrographic and geodetic engineers have resigned from this service. Most of these were particularly competent officers who had had considerable training. Besides these, and within the same period of time, 7 of our commissioned aids have resigned, and it has been intimated to me that 2 or 3 additional junior hydrographic and geodetic engineers, as well as many aids, will resign in the near future. These resignations come to us not because of any dislike for the service in this Bureau. For the most part they are tendered reluctantly, because the men dislike to leave this service, but opportunities for better pay, even better initial pay, are offered elsewhere, and advancement is more rapid and expectant.

### INVESTIGATION OF THE USE OF THE AIRPLANE FOR MAKING SURVEYS.

Another need of the field service is an investigation of the possibilities of the use of the airplane in making topographic surveys and hydrographic examinations, as well as revisionary surveys. Airplane photographs were used to a very great extent during the war in locating military features of the enemy. The same principle employed in the military work can be used in surveying and mapping, but a large amount of research work will have to be done before the airplane photograph will give the accuracy required of the highest class of surveying done by this and other organizations.

It is a very difficult matter to keep the topographic features up to date on the 700 charts of the United States Coast and Geodetic Survey with the old methods, but it is possible in many cases, and especially in a flat country, to make very rapid revision of the shore line and adjacent land areas by means of photographs taken from airplanes.

The Coast and Geodetic Survey during the past year has been in close cooperation with the air service of the Army and Navy in making certain tests which indicate that suitable results may soon be expected. In fact, the best method, with proper handling of the airplane during the time that the photographs are being taken, will give results which can be used on at least small-scale charts of this Survey.

The mapping of the country adjacent to the shore where there is considerable relief is at present not practicable from the airplane on account of the great amount of work that would be involved in reducing the photographs to the map, but it is believed that methods will be developed by which this will be done more expeditiously, and then there will be no limit to the character of terrain on which the airplane can be used for surveying.

It must not be supposed that the airplane can entirely supersede the usual methods of surveying. We shall still need triangulation and traverse to give the fundamental control for the work, and much planetable work will have to be done to locate topographical features which may be used in the control of the position of the airplane photographs. It is also probable that the planetable will still be the method for placing the contours on the maps. While it is possible to obtain some idea of the relief of the country from overlapping airplane photographs, at the same time the problem of placing contours accurately on the map is one which will be difficult to solve. The office expense of contouring a map from airplane photographs will, undoubtedly, be greater than by an instrumental party working in the field, if the contouring is to be of a higher grade of accuracy.

The most promising field for surveying and mapping from an airplane is over flat country, or country with low relief, and in revision surveys where the contouring has already been accurately done. The changing features are shore lines, woods, roads, villages, and these features can be readily placed on the old map by fitting in the new features shown on the photograph, to the unchanged features shown both on the old map and on the photograph. It is in this revision work that the Coast and Geodetic Survey expects much help from the air services of the Army and of the Navy.

What seems to be most desirable at present is that we should have a research laboratory connected with the air service of the Army or of the Navy at which various methods and instruments might be tested. Such a laboratory should be preferably, in the vicinity of Washington, where the Government survey and mapping organizations are located.

This Bureau and other surveying and mapping organizations of the Government have frequently called to the attention of the public the desirability of having our vast area mapped at an early date for the benefit of commerce and industry. There is hardly a human effort that is not more or less dependent upon some kind of a map, and the more accurate the map the greater its use to commerce and industry. There are many sparsely settled places in the United States where elaborate maps could not be justified, on account of the time and expense involved in their preparation. But there are many other communities where there are no maps to-day, where we would be far better off if we had an accurate map for the extension of roads, utilization of water power, and many other branches of human activity.

The Coast and Geodetic Survey is doing what it can in the interest of the country in establishing the control for accurate maps. This work has been more vigorously carried on in the past two years.

For the next fiscal year I have asked for a considerable increase in the amount of money to be devoted to this control work, and I hope that Congress will see its way clear to grant this increase, for it is undoubtedly true that the public will be benefited every year many times the cost of the original surveys.

On account of the great need of the public for maps, both along the coast and in the interior, the airplane photographs should be developed to such an extent that the usual methods of surveying could be supplemented by the airplane photograph and the work very greatly expedited. To this end the Coast and Geodetic Survey will lend its energy and support.

# CHAPTER II.

## WHAT HAS BEEN DONE DURING THE FISCAL YEAR.

In the 1918 annual report of this Bureau the field accomplishments for the year were summarized under the following classifications:

Hydrography: (1) Ship and launch hydrography, (2) wire-drag surveys, (3) revision work, (4) current observations, (5) tidal observations, and (6) topography.

Geodesy: (1) Triangulation, (2) precise levels, and (3) magnetic observations.

These same classifications will be adhered to in summarizing the work accomplished during the fiscal year ended June 30, 1919.

### HYDROGRAPHY.

This country was at war with Germany during the period this report covers and the naval needs of the country called for the use of all able vessels for one purpose or another, so it was very late in the fiscal year 1919 before any vessels could be released for civil duties. By the Executive order of September 24, 1917, three vessels of the Coast and Geodetic Survey (the *Surveyor*, the *Bache*, and the *Isis*) were transferred to the service and jurisdiction of the Navy Department for temporary use, and by the Executive order of May 16, 1918, two vessels of the Coast and Geodetic Survey (the *Explorer* and the *Patterson*) were likewise transferred to the service and jurisdiction of the Navy Department. The vessels thus taken over by the Navy Department were retained until late in the fiscal year 1919, an Executive order having been issued under date of February 26, 1919, authorizing their return to the Coast and Geodetic Survey by April 1, 1919. By the Executive order of May 24, 1919, under authority of the act of Congress, chapter 78, section 2, approved May 20, 1918, the Secretary of the Navy is authorized to transfer—

> any or all vessels, boats, and auxiliary ships of the Navy classified as yachts, colliers, transports, tenders, supply ships, hospital ships, submarine chasers, patrol boats, motor boats, fishing vessels, and special types built, purchased, or commandeered for a substantial consideration by the Navy subsequent to the declaration of Congress by joint resolution approved April 6, 1917, that war exists between the United States and Germany, and provided said vessels were built, purchased, or commandeered for the purposes of said war, and any other executive department of the Government is desirous of securing from the Navy Department such vessels, boats, and auxiliary ships, or any of them which are, in the opinion of the Secretary of the Navy, not necessary for the needs of the Navy, upon such terms as may be agreed to by the executive head of such department and the Secretary of the Navy.

Acting under this authority the following vessels of the Navy Department were transferred to the service and jurisdiction of the Coast and Geodetic Survey: *Natoma*, April 9, 1919; *Wenonah*, April 12, 1919; *Onward*, April 19, 1919; *Ranger*, April 28, 1919; *Arcturus*, May 5, 1919.

The following table gives a condensed statement of the vessels at the disposal of the Coast and Geodetic Survey within the fiscal year:

| Name of vessel. | Transferred to Coast and Geodetic Survey by Navy. | Loaned to Coast and Geodetic Survey by Philippine Government. | Owned by Coast and Geodetic Survey at beginning of fiscal year. | Sold during the fiscal year. |
|---|---|---|---|---|
| Arcturus | 1 | | | |
| Bache | | | 1 | |
| Cosmos | | | 1 | |
| Explorer | | | 1 | |
| Fathomer | | 1 | | |
| Hydrographer | | | 1 | |
| Isis | | | 1 | |
| Matchless | | | 1 | 1 |
| Natoma | 1 | | | |
| Onward | 1 | | | |
| Pathfinder | | | 1 | |
| Patterson | | | 1 | |
| Ranger | 1 | | | |
| Romblon | | 1 | | |
| Surveyor | | | 1 | |
| Wenonah | 1 | | | |
| Total | 5 | 2 | 9 | 1 |

| | |
|---|---|
| Transferred from Navy | 5 |
| Loaned by Philippine Government | 2 |
| Owned by Coast and Geodetic Survey | 9 |
| Total | 16 |
| Sold during the year | 1 |
| Total vessels at disposal of the Survey at end of fiscal year | 15 |

The following is a brief statement of the assignments of the 17 different vessels at the disposal of the Coast and Geodetic Survey at some time within the fiscal year:

*Arcturus.*—This vessel was transferred to the Coast and Geodetic Survey by the Navy Department under authority of the Executive order of May 24, 1919, above cited. The transfer was effected May 5, 1919. She was stationed at New York City when taken over. From the time of the transfer to the close of the fiscal year she remained at New York where she was being put into condition for making surveys for this Bureau.

*Bache.*—The *Bache* was returned to the Coast and Geodetic Survey from the Navy Department by authority of the Executive order of February 26, 1919, which directed that she be returned not later than April 1, 1919. From that time until the end of the fiscal year she was being put into condition to take up survey work for the Bureau.

*Cosmos.*—The *Cosmos* is a small vessel used by the Bureau when making inshore surveys in Alaskan waters. When not in commission she is pulled out of the water and stored in a boathouse maintained by the Bureau. She was in commission from July 25 to September 30, 1918. During the rest of the year she was in storage.

*Explorer.*—The *Explorer*, which had been taken over by the Navy Department by the Executive order of September 24, 1917, was retained by the Navy until April 1, 1919, when she was transferred to the Coast and Geodetic Survey by authority of the Executive order of February 26, 1919. In my report for the fiscal year ended

June 30, 1917, on page 60 I made the following statement regarding the *Explorer*:

> In the design and construction of this vessel, it was endeavored to provide for the utmost space in her. To provide this space, some of the strengthening members usually provided in a vessel were omitted. While no weakness was noticed in consequence of the absence of these strengthening members during her earlier work, she is now showing their absence, and in rough seas her sides are pliable to the extent that the bolts holding them together are subject to shearing stresses, and if she is continually employed in rough seas, it means that she will ultimately become too weak to be of any service.

Because of this structural weakness and the belief that the vessels which have been received from the Navy, after they have undergone certain alterations, will be capable of executing more work at the same cost, and the same amount of work at less cost than will be possible with the *Explorer*, no attempt has been made to put her in the field since her return from the Navy. She will, however, be used temporarily as a housing vessel for detached parties in Alaskan waters.

*Fathomer.*—This vessel operated in the Philippine waters and was in commission throughout the entire fiscal year.

*Hydrographer.*—This vessel was in commission throughout the entire fiscal year in Atlantic coast and Gulf coast waters.

*Isis.*—This vessel was returned to the Coast and Geodetic Survey by the Navy Department by authority of the Executive order of February 26, 1919, which provided that she should be returned by April 1, 1919. From the time of her return to the close of the fiscal year she was being outfitted and overhauled to fit her for resuming her normal surveying duties.

*Matchless.*—This vessel is a wood, two-masted schooner. She was built at Key West, Fla., in the year 1859. Of late years she has been used as a house-boat from which parties operated in making surveys of inland waters. Experience developed the fact that she was no longer economically operated, even for this purpose, and accordingly, the necessary steps were taken and she was sold June 28, 1919.

*Natoma.*—This vessel was transferred to the Coast and Geodetic Survey from the Navy Department by authority of the Executive order of May 24, 1919. The transfer was effected April 9, 1919. From that date until May 23 she was being put into condition to take up survey work for this Bureau. Her field of operation will be on the Pacific coast. She left New York on May 23 for the Pacific coast and had reached the Canal Zone June 30.

NOTE.—While the *Natoma* had not reached her field of operation by the close of the fiscal year for which this report is written, it was particularly gratifying to me to receive a letter from our inspector in charge of our field station at San Francisco, Calif., under date of July 31, 1919, containing the following statement: "The arrival of the *Natoma* was particularly timely, as a request had been received from Admiral Rodman, in command of the Pacific Fleet, for an examination of the Bonita Channel, and in particular the location of the 5-fathom curve on the western edge of the channel, along the 'Potato Patch.'" Admiral Rodman asked that the result of the examination be furnished him on or before August 10. At the date of this report the work is in progress.

*Onward.*—This vessel was transferred to the Coast and Geodetic Survey from the Navy Department by authority of Executive order of May 24, 1919. The transfer was effected April 19, 1919; from that date until the close of the fiscal year she was being overhauled and altered for the purpose of taking up survey work for the Coast and Geodetic Survey.

*Pathfinder.*—This vessel operated in Philippine waters throughout the entire fiscal year.

*Patterson.*—In my report for the fiscal year ended June 30, 1917, on page 61 I made the following statement regarding the *Patterson:*

> The barkentine *Patterson* is structurally too weak to be used in exposed waters and too expensive of operation to be used as a house-boat for inside surveys. She has lately been employed in making surveys of the inside Alaskan waters, but is such an antiquated craft that the overhead cost of operation makes the results far less in quantity and more costly than they would be with a modern vessel. The *Patterson* was built 35 years ago.

By the Executive order of February 26, 1919, the *Patterson* was directed to be returned to the Coast and Geodetic Survey not later than April 1, 1919. Under date of May 26, 1919, I made the following recommendation to you regarding the *Patterson:*

> The *Forward*, ex-*Patterson*, is virtually an auxiliary sailing vessel of such small steaming power that she can not make headway against a heavy wind. Consequently, her use on an exposed coast where there are no harbors is hazardous. As hydrography can not be efficiently executed to-day under sail, the only use to which this vessel can be put as a surveying craft is in the transportation of parties between Seattle and Alaska. On arrival in Alaska she is of little use except as a house-boat, because her low power and slow speed prevent her from executing enough hydrography to justify the cost of operation. The Bureau considers this an inefficient way to operate a hydrographic party.

It accordingly has met with your approval, that she be disposed of, and this will be done as soon as the necessary formalities can be complied with.

*Ranger.*—The *Ranger* was transferred to the Coast and Geodetic Survey from the Navy Department under authority contained in Executive order of May 24, 1919. The transfer was effected April 28, 1919. Parties from her effected local surveys in New York Harbor between the date of transfer to the close of the fiscal year. At the same time she was being overhauled and outfitted for purposes of going to the field and making surveys.

*Romblon.*—This vessel was employed in making surveys of the Philippine waters throughout the fiscal year.

*Surveyor.*—She was returned from the Navy Department under authority of the Executive order of February 26, 1919. The return was effected April 1, 1919. From April 1 to April 21, she was at Norfolk, Va., in preparation for leaving for the Pacific coast to take up surveys in Alaskan waters. En route to Alaska she took deep-sea soundings on the steamer track from Norfolk to the Panama Canal and from the Panama Canal to San Diego, Calif. She had not reached Alaskan waters by the close of the fiscal year.

*Wenonah.*—This vessel was transferred to the Coast and Geodetic Survey from the Navy Department by authority of the Executive order of May 24, 1919. The transfer was effected April 12, 1919. From that date until June 7, the vessel was being overhauled and outfitted. On April 7 the vessel left for the Pacific coast, where she will be employed in making surveys. She also took deep-sea soundings en route to the Pacific coast.

As to the relative size of surveying vessels now controlled by this Bureau, I believe the following statement will be instructive:

| | Gross tonnage. | | Gross tonnage. |
|---|---|---|---|
| Surveyor | 1,000 | Explorer | 335 |
| Pathfinder | 690 | Wenonah | 240 |
| Patterson | 500 | Ranger | 219 |
| Arcturus | 456 | Onward | 157 |
| Fathomer | 431 | Matchless | 118 |
| Romblon | 411 | Hydrographer | 116 |
| Isis | 377 | Natoma | 112 |
| Bache | 370 | | |

*Ship and launch hydrography.*—

| | Square statute miles. |
|---|---|
| Ship hydrography performed during the fiscal year: | |
| Chesapeake Bay | 435 |
| Vicinity of Key West, Fla | 72.2 |
| Hampton Roads and vicinity | 277 |
| Philippine Islands | 2,885.5 |
| Total | 3,669.7 |
| Launch hydrography: | |
| Turtle River, Ga | 1.8 |
| Miami, Fla | 82 |
| Morro Bay, Calif | 4 |
| Cook Inlet, Alaska | 1.3 |
| Philippine Islands | 320.6 |
| Total | 409.7 |

*Wire-drag surveys.*—There were five wire-drag parties in the field within the year. For purposes of identification they were given designation numbers.

| | Square miles. |
|---|---|
| Wire-drag party No. 1: This party was in the field from July 1 to November 25, 1918. It operated in Long Island Sound, Fishers Island Sound, Block Island Sound. It covered | 97 |
| Wire-drag party No. 2: This party was in the field from July 1 to November 15, 1918. It operated along the New England coast and in Passamaquoddy Bay. It covered | 220.6 |
| Wire-drag party No. 3: This party was in the field from July 1 to September 27, 1918. It operated in Cook Inlet, Alaska. It covered | 24.8 |
| Wire-drag party No. 4: This party was in the field from April 18 to June 5, 1919. It operated in Lake Tahoe, Calif. It covered | 30 |
| Wire-drag party No. 5: This party was in the field from July 1 to November 26, 1918. It operated in Long Island Sound, Fishers Island Sound, Block Island Sound. It covered | 138.2 |
| Total | 510.6 |

*Revision surveys.*—Revision surveys were made in the localities named below.

| | Square miles. |
|---|---|
| Coast of Massachusetts | 68 |
| Pascagoula, Miss | 5 |
| Commencement Bay, Wash | 9 |
| Total | 82 |

*Current observations.*—As you are aware, Congress last year authorized a nominal extra compensation to employees of the Bureau of Lighthouses stationed on lightships when they are engaged in making current observations for this Bureau. Observations were begun as soon as instruments could be procured and installed. The table below shows what was accomplished during the year:

| Light vessel. | State. | Station. | Time employed. | | |
|---|---|---|---|---|---|
| | | | Y. | m. | d. |
| Portland | Maine | 1 | 0 | 0 | 13 |
| Pollock Rip Slue | Massachusetts | 1 | 0 | 5 | 20 |
| Stone Horse Shoal | ....do | 1 | 0 | 6 | 0 |
| Finch | New York | 1 | 0 | 3 | 4 |
| Nantucket Shoal | Massachusetts | 1 | 0 | 7 | 0 |
| Cardinal | New York | 1 | 0 | 1 | 0 |
| Falcon | New Jersey | 1 | 0 | 3 | 24 |
| Northeast End | ....do | 1 | 0 | 9 | 0 |
| Overfalls | Delaware | 1 | 0 | 6 | 0 |
| Brant | Virginia | 1 | 0 | 4 | 0 |
| Winter Quarter | ....do | 1 | 0 | 9 | 0 |
| Tail of the Horse Shoe | ....do | 1 | 0 | 2 | 0 |
| Diamond Shoal | North Carolina | 1 | 0 | 2 | 0 |
| Cape Lookout | ....do | 1 | 0 | 9 | 0 |
| Frying Pan Shoals | ....do | 1 | 0 | 9 | 0 |
| Long Island | South Carolina | 1 | 0 | 2 | 0 |
| Brunswick | Georgia | 1 | 0 | 7 | 0 |
| Heald Bank | Texas | 1 | 0 | 4 | 0 |
| San Francisco | California | 1 | 0 | 9 | 0 |
| Blunts Reef | ....do | 1 | 0 | 9 | 0 |
| Columbia River | Oregon | 1 | 0 | 7 | 0 |
| Umatilla Reef | Washington | 1 | 0 | 6 | 0 |
| Swiftsure | ....do | 1 | 0 | 6 | 0 |
| Total | | 23 | 10 | 7 | 1 |

Short series of current observations were made at the following localities:

| Locality. | Stations. | Time employed. | |
|---|---|---|---|
| | | m. | d. |
| Cape Porpoise Harbor, Me | 1 | 0 | 3 |
| Portsmouth Harbor and vicinity, N. H | 5 | 0 | 23 |
| Block Island Sound, R. I | 4 | 0 | 11 |
| York River, Va | 6 | 0 | 14 |
| Hampton Roads, Va | 7 | 0 | 21 |
| Chesapeake Bay, Va | 11 | 0 | 24 |
| Pamlico Sound, N. C | 6 | 0 | 9 |
| Mobile Bay, Ala | 5 | 1 | 3 |
| Mississippi Sound, Miss | 7 | 0 | 15 |
| Rigolets, La | 3 | 0 | 11 |
| Morro Bay, Calif | 2 | 0 | 4 |
| Total | 57 | 5 | 18 |

*Tidal observations.*—Tidal observations were made throughout the year at the following permanent tidal stations:

1. Portland, Me.
2. Fort Hamilton, N. Y.
3. Atlantic City, N. J.
4. Philadelphia, Pa.
5. Baltimore, Md.
6. Fernandina, Fla.
7. Key West, Fla.
8. Cedar Keys, Fla.
9. Galveston, Tex.
10. San Diego, Calif.
11. San Francisco, Calif.
12. Seattle, Wash.

Important tidal observations were made at the following stations:

1. St. Andrew, New Brunswick.
2. Midjik Bluff, New Brunswick.
3. Eastport, Me.
4. Jonesport, Me.
5. Block Island, R. I.
6. Stonington, Conn.
7. Little Gull Island, N. Y.
8. New Suffolk, N. Y.
9. Sandy Hook, N. J.
10. Breakwater Harbor, Del.

11. Cape Charles City, Va.
12. Fishermans Island, Va.
13. Gloucester Point, Va.
14. York River, Davis Wharf, Va.
15. Thimble Shoal Lighthouse, Va.
16. Wolftrap Lighthouse, Va.
17. York Spit Lighthouse, Va.
18. Back River, Va.
19. Old Point Comfort, Va.
20. Miles Watch House, Va.
21. Middle Ground Lighthouse, Va.
22. Newport News, Va.
23. Sewall Point, Va.
24. Lynnhaven Roads, Va.
25. Brunswick, Ga.
26. St. Augustine, Fla.
27. Miami, Fla.
28. Cutler, Fla.
29. Cape Florida, Fla.
30. Fort Morgan, Ala.
31. Pinto Island, Ala.
32. Alabama Port, Ala.
33. Weeks Bay, Ala.
34. Great Point Clear, Ala.
35. Morro, Morro Bay, Calif.
36. The Strand, Morro Bay, Calif.
37. Ketchikan, Alaska.
38. Craig, Alaska.
39. Petersburg, Alaska.
40. Port Chatham, Alaska.
41. Anchorage, Alaska.
42. Malbinchilao Island, P. I.
43. Illulluk Bay, P. I.
44. Mericaban Barrio, P. I.

*Topography* in connection with hydrographic work was executed as follows:

| | Square miles. |
|---|---|
| Vicinity of Hampton Roads and York River, Va | 11.5 |
| Turtle River, Ga | 2.2 |
| Virgin Islands | 55.5 |
| Vicinity of Morro Bay, Calif | 10.5 |
| Vicinity of Keete Inlet, Alaska | 16 |
| Vicinity of Cook Inlet, Alaska | 1 |
| Philippine Islands | 511.7 |
| Total | 608.4 |

## GEODESY.

*Triangulation.*—Primary triangulation was executed from the ninety-eighth meridian, in the vicinity of Waco, Tex., to Robeline, La. The length of the scheme is 255 miles, and an area of 3,570 square miles was covered. Secondary triangulation was run from Sanford, N. C., to the vicinity of Madison, N. C. The length of the scheme is 120 miles, and the area covered is 1,700 square miles. Secondary triangulation was also run from Turkey Point Light to Sandy Point Light, Chesapeake Bay. The length of this scheme is 37 miles, and the area covered is 210 square miles.

Tertiary triangulation: Morro Bay, Calif., length of scheme, 5 miles; area covered, 8 square miles. Key Biscayne, in the vicinity of Miami, Fla., length of scheme, 15 miles; area covered, 42 square miles. Vicinity of Charleston, S. C., length of scheme, 14 miles; area covered, 27 square miles.

Primary traverse: A primary traverse was run from Vaughan, N. C., to Blaney, S. C. The length of the line of primary traverse is 235 miles. Another primary traverse was run from Wilmington to Sanford, N. C. The length of this line is 125 miles.

Reconnoissance: One arc of reconnoissance extends from the vicinity of Waco, Tex., eastward to Robeline, La. The length of this reconnoissance is 255 miles. Another reconnoissance was run in the vicinity of Prescott, Ariz. This reconnoissance is 50 miles in length. Also a line of reconnoissance, 50 miles in length, was run in the vicinity of Richfield, Utah.

The following summary gives the statistics of the above accomplishments:

| | Length of scheme. | Area covered. |
|---|---|---|
| | *Miles.* | *Square miles.* |
| Primary triangulation | 255 | 3,570 |
| Secondary triangulation | 157 | 1,910 |
| Tertiary triangulation | 34 | 77 |
| Total | 446 | 5,557 |
| Reconnoissance | 355 | |
| Primary traverse | 360 | |

*Precise levels.*—There were 1,190 miles of precise leveling run during the fiscal year 1919. The lines of precise leveling are as follows:

| | Miles. |
|---|---|
| Jeanerette to New Orleans, La | 115 |
| Fifteen miles east of Pensacola to River Junction, Fla | 124 |
| Four miles south of Margaret to Moncure, N. C | 155 |
| Blaney, S. C., to Moncure, N. C | 149 |
| Wilmington to Sanford, N. C | 132 |
| Greensboro to Sanford, N. C | 47 |
| Harlingen to Eagle Pass, Tex | 311 |
| Hillsboro, Tex., eastward (estimated) | 82 |
| Troy to Whitehall, N. Y | 75 |
| Total | 1,190 |

*Magnetic observations.*—In the continuation of the magnetic survey of the United States, observations were made during the year at 77 stations in 11 States, of which 34 were new primary stations, 17 auxiliary stations, 22 repeat stations for the determination of secular change, and 4 new stations in old localities. Meridian lines were established when they were requested by the local authorities.

The observatories at Cheltenham, Md., Vieques, P. R., Tucson, Ariz., Sitka, Alaska, and near Honolulu, Hawaii, were in operation throughout the year. A continuous photographic record was secured of the variations of declination, horizontal intensity, and vertical intensity. Absolute observations were made at least once a week.

# CHAPTER III.

## SHOWING CONDITIONS AND NEEDS OF HYDROGRAPHIC AND GEODETIC SURVEYS, WITH ILLUSTRATIONS—UNITED STATES AND POSSESSIONS.

### HYDROGRAPHIC SURVEYS.

The discussion of the condition of the hydrographic surveys of our coasts is taken up section by section from northward to southward on the Atlantic coast and southward to northward on the Pacific coast. It is, of course, impossible within the limit of the scope of this volume to give a detailed analysis of conditions for every small inlet, bay, and harbor. What will be undertaken will be to show in general terms the condition of the surveys of the important areas and what needs to be done to enable the charting of all dangers to navigation, many of which are now suspected but undetermined. To facilitate reference to the text and to the locality, I have inserted diagrams on which the important steamer courses are indicated and numbered and the paragraphs of the text relating to these areas bear corresponding numbers.

1. *Deep draft, along-shore course from the Canadian boundary to the outer limit of Isle au Haut Bay.*—The entire area that this course covers is a region of ledges and bowlders. The ledges rise abruptly from the deep water and the bowlders ordinarily lie singly or in clusters on an otherwise flat bottom, so that the navigator can not depend on the lead to avoid them. This area is as yet untouched by the wire drag with the exception of a section about 15 miles in extent between Machias Seal Islands and Petit Manan Island. There are a number of towns along this course that depend largely on water-borne traffic for their supplies. The commerce consists in fuel and miscellaneous merchandise constituting the supply of the smaller and larger fashionable summer resorts, of which the largest is Bar Harbor, Me. The exceptionally rocky coast makes it certain that a wire-drag survey will result in the discovery of many rocks which now endanger the safety of commerce over this course.

2. *Frenchman Bay.*—This body of water lies westward of Schoodic Peninsula and eastward of Mount Desert Island. It is the approach to the town and important summer resort of Bar Harbor, Winter Harbor, South West Harbor, North East Harbor, and many small villages. The bay is frequented by many passenger steamers, yachts, small craft, fishing vessels, and a few cargo vessels. This area has been dragged, though not to depths now considered necessary. The value of the work is further impaired by the necessity of passing over not less than 14 miles of undragged, doubtful area in order to reach the bay from the open sea.

3. *Inland thoroughfares from Mount Desert Island to Rockland.*—There is a series of valuable inside passages along the Maine coast that are very narrow in places and wind between rocky ledges. Owing to the nature of the bottom they are particularly likely to be obstructed by pinnacle rocks or the extension of narrow ridges out into the channel. The only part of these channels which has been dragged lies between Blue Hill Bay and the western entrance of Penobscot Bay. The results obtained have been so startling that they clearly indicate danger in the use of channels that have been dragged.

4. *Penobscot River.*—This river, emptying into the head of Penobscot Bay, forms the approach to the towns of Bucksport, Winterport, Hampden, and Brewer, and the city of Bangor, the latter two at the head of navigation, about 24 miles above Fort Point Lighthouse at the entrance. It has considerable trade in regular steamer drawing about 10 feet, and many vessels of deepest draft ordinarily trading to Bangor being about 18 feet. Practically the entire river above Bangor is used in lumbering. From the mouth of the river to Bangor there is no positive certainty of the absence of all dangers to navigation until the area has been dragged.

5. *Penobscot Bay.*—In Penobscot Bay every port has benefited by the practical completeness of the wire-drag work. There are, however, some of the less important sections to be dragged and some of the approaches from the eastward are not yet completed. The wire drag, as used by the Coast and Geodetic Survey, was developed in this region, and some of the area was not dragged to the depth now believed necessary. The size of vessels has increased rapidly, and additional work is necessary to protect this increased draft. As it has required time to solve all the problems involved in dragging to this greater depth, it is probable that much of the deeper part of Penobscot Bay will later have to be dragged to a greater depth.

6. *Penobscot Bay to Casco Bay* (*deep draft*).—The coast of New England throughout its length presents practically one uniform problem to the hydrographic engineer. Surveys of varying degrees of completeness have been made of the entire area, and it is possible for navigators to select channels which are apparently safe. They would be of ample depth if it were not for the ice-worn granite rock or the large bowlders deposited during the glacial period. The lead line is not adapted to find without assistance dangers of this character. This thoroughfare presents uneven and rocky bottom between Monhegan Island and the eastern entrance to Casco Bay, which should be dragged to remove all doubt of the existence of pinnacle rocks or small ledges.

7. *Penobscot Bay to Casco Bay* (*moderate draft*).—From the western entrance of Penobscot Bay to Casco Bay there has been no wire-drag work done. The inside route is constantly used by coasting steamers, but it is certain that it has within its limit many uncharted rocks, some known locally and some unknown.

8. *Booth Bay Harbor.*—This forms the approach to the town of Booth Bay Harbor and numerous smaller summer resorts. It is fre-

quented by many vessels, and by a large number of fishing boats and pleasure craft in summer. It is one of the best anchorages on the coast of Maine and is much used as a harbor of refuge by all classes of vessels. This area is in urgent need of a wire-drag survey.

9 *Kennebec River.*—It is the approach to the cities of Bath and Augusta, the towns of Woolworth, Richmond, and Gardiner, and numerous smaller villages and summer resorts. The river has considerable water-borne commerce. The deepest draft being about 21 feet to Bath and 14 feet to Augusta. There is urgent need for a wire-drag survey of this river.

10. *Casco Bay.*—Casco Bay and the approaches to Portland have been dragged with the result of finding numerous uncharted shoals, thereby furnishing important evidence of the need of completing the survey to the eastward and westward. A resurvey of inner Casco Bay is badly needed, the glaciers having left a series of long narrows and dangerous ledges which require closer examination.

11. *Portland Harbor and approaches.*—These have been dragged, and all dangers to navigation are shown on the charts.

12. *Portland to Portsmouth (moderate draft).*—Westward of Portland the succession of sand beaches, of which Old Orchard is the best known, might appear to indicate an absence of rocks in this region. The depth of sand above the underlying rock is not great, however, and pinnacle rocks occur outside these beaches. Southward of Cape Porpoise the surveys are entirely inadequate, and the need of immediate surveys is evident by the appearance on the chart of a rocky shoal with 5 fathoms or less, marked "position doubtful." This was recently reported by a fisherman, but it has not yet been practicable to locate it. However, arrangements are made to extend the wire-drag survey from Boon Island to a junction with the wire-drag work at Cape Elizabeth, Me., beginning July 1, 1919. This will include the area reported dangerous.

13. *Portland to Cape Ann (deep draft).*—The region from Boon Island to Isle of Shoals is very rocky, and its importance as the approach to Portsmouth is so well recognized that work is now progressing, on the completion of which a perfectly safe track will be provided from Portland to the vicinity of Cape Ann.

14. *Portsmouth Harbor.*—This area has been dragged, and all dangers to navigation are known.

15. *Massachusetts coast north of Cape Ann.*—From the New Hampshire border to Cape Ann the shores are entirely different from those to the north or south. There are high sand bluffs in places and low sandy shores in others. As a result the depths along the shore are changeable, and though they have been recently surveyed, they will need further attention.

16. *Cape Ann to Cape Cod Canal.*—A completely dragged area extends from Cape Ann to the Cape Cod Canal and from the head of Buzzards Bay to Sakonnet Point, R. I. With the exception of the inner part of Boston Bay and the areas near the shores of Buzzards Bay, this important survey is complete. This work was made

especially necessary by the opening of the Cap Cod Canal in 1915, the original surveys having been made while the commerce of the region was relatively unimportant. A number of shoals were found of less than the proposed canal depth, so that the needs would at some further date make it necessary to deepen this canal to take care of the largest vessels. With this view, the drag was carried at a sufficient depth to meet such requirements. Even should a depth of 40 feet be adopted for the canal, the present surveys of the approaches will be found adequate, and where less depths have been found the information will be invaluable to the engineers making the improvement.

17. *From Boston south outside Cape Cod.*—Much of the traffic between eastern New England and points west and south passes outside of Cape Cod; most of it through Nantucket and Vineyard Sounds. Off Cape Cod the surveys are not complete. In Nantucket Sound the entire route is through channels bounded by shifting sand, and require revision work from time to time. In one part of the channel most used, through Pollock Rip Slue, a shoal was formed in the last few years that has been steadily narrowing and decreasing the depth of the channel. A resurvey of parts of this route is needed every few years to insure safety to navigation. No rocks around eastward of Cape Cod, but in the north half of Nantucket Sound and the western part of Vineyard Sound large bowlders occur and wire-drag work is needed. At present vessels must pass over 10 miles of undragged area in following the best channel through Vineyard Sound.

18. *From Cape Cod Canal through Buzzards Bay.*—This route has been dragged out to the eastern limit of Block Island Sound.

19. *Narragansett Bay.*—This area has been dragged with the exception of the thoroughfare leading through Mount Hope Bay to Fall River, and the small stretch to the north and east of Prudence Island.

20. *Entrance to Narragansett Bay, Block Island Sound, Fishers Island Sound, and eastern part of Long Island Sound.*—These areas are in a stage of completion. The work of the present season will complete their survey with the exception of the central and western parts of Long Island Sound, which remain to be dragged.

21. *Gulf of Maine.*—The portion of the Gulf of Maine of which this Bureau makes surveys may be considered as lying to the westward of meridian 67° 0′ and extending to Nantucket Shoals. This entire area has been surveyed, but the surveys are inadequate. Not only are the soundings obtained insufficient, but many of them are not located correctly on the charts. A good example of this is the discovery several years ago that only one shoal rock exists on Cashes Ledge, where two were charted, and that Sigsbee and Ammen Rocks, formerly shown 4 miles apart, are really the same rock. These defects in the charts are serious for two reasons: The trans-Atlantic steamers approaching the ports of northern New England, especially Portland and Boston, are unable to depend on the charts of the gulf sufficiently to locate themselves accurately by sounding. This is particularly serious during the fog of summer which often extends

far out to sea and lasts for days, and during the winter snowstorms. In addition to this, the fisheries of the Gulf of Maine are an important national asset. Not only are many important fishing banks uncharted, but the limit and depths of known banks are not correctly given. Besides, there is not at present enough information available as to the character of the bottom. The knowledge of rocky bottom may lead to the discovery of good fishing grounds.

22. *Nantucket Shoals to Georges Banks.*—Extending eastward from Nantucket Sound there is an immense shoal area, consisting of sandy ridges which are shifted by the waves and currents. Nantucket Shoals extend about 50 miles offshore, then there is a deep channel followed by ridges. It is readily seen that it is important to keep the channel surveyed and to examine the adjacent shoals to detect changes; but it might readily be asked, What is the use of surveying such areas as Nantucket Shoals, which vessels are most careful to avoid? First, it is necessary to be certain that the outer limits of these shoals are clearly defined in order that they may be avoided. Second, the shoals are important fishing grounds. Third, more careful surveys may develop safe channels for coastwise navigation—channels which are already indicated on the charts but are unsafe to use because of inadequate surveys. The existing surveys are nowhere adequate. The shoals are so numerous and the channels so intricate that a difficult problem is presented in their examination by accurate methods. The ground fishing, which has in recent years assumed large proportions, is steadily moving seaward. During the winter Nantucket Island is the headquarters of this industry. Not only do the present charts lack the needed information in the search for new grounds, but the absence from the charts of existing shoals is a source of danger to the boats running to and from the harbor. Breakers often occur where there is ample depth for boats when the water is smooth. This is an excellent example of how a region usually avoided by commerce may be of importance to an industry which furnishes part of the food supply of the Nation.

23. *Trans-Atlantic approach to New York.*—There is scarcely any part of our coast where correct soundings are of more importance than in the approach to New York from the eastward, as all trans-Atlantic steamers bound to that port pass over this area. Many of them have to depend on soundings for safety. A fairly good survey of this area is available, but additional work should be done by modern methods in the portion out of sight of land so that the needs of the enormous traffic will be met.

24. *From Point Judith to New York.*—It is almost unnecessary to go into particulars except to make it clear that the central and western parts of Long Island Sound remain to be dragged. This work will be undertaken at the earliest opportunity. The project to deepen East River to 40 feet makes it necessary to be certain where the channels with such depths are located in Long Island Sound. The work done in Block Island Sound has defined the limit of such depths in the eastern approach to Long Island Sound, and it is urgent that the entire area should be completed without delay. The approaches to all the harbors on Long Island Sound should be

dragged. The shoaler bays are filled with motor boats, and the number in operation for a given area is probably greater than anywhere else in the United States.

25. *Hudson River.*—The Hudson River is a valuable waterway between New York and Albany and is a part of the canal system of the State. A few years ago a dangerous rock was found directly in the path of steamers between New York and Albany. With such a possibility all the doubtful part of the Hudson should be dragged.

26. *New York Harbor.*—New York Harbor has had a recent survey, but as it is an area subject to change, it will require a survey, at least in part, every few years.

27. *Coast of New Jersey.*—Along the most of the coast of New Jersey the character of the bottom is such that the exact existing depths should be ascertained beyond all doubt, particularly as shoals dangerous to coastwise traffic have been reported from time to time. The only reliable surveys along this stretch of coast have been made in connection with searches for these reported shoals. Eastward of Cape May there are shoals that need a resurvey. Arrangements have been made to begin a survey from Cape Henlopen to New York on July 1, 1919. This survey will extend out to the 100-fathom curve.

28. *Delaware Bay.*—Delaware Bay has as its most marked characteristic a series of narrow, fairly deep channels separated by long, narrow shoals. These shoals are subject to change. A survey is needed now, and one should be made about every 10 years in the entrance, and at longer intervals in the upper bay. While dredged channels are maintained for most of the distance from the entrance of the bay to Philadelphia, vessels of moderate draft use the other channels. In view of the importance of the cities at the head of the bay and on the river it is highly important that the needed survey of Delaware Bay be made so that a chart of the proper standard may be issued.

29. *Delaware Bay entrance to Chesapeake Bay.*—From Delaware Bay entrance to Chesapeake Bay there is a succession of shoals and banks. Many of these are buoyed so that moderate-draft vessels may pass inside of them. In certain regions it is of the highest importance that the survey should be correct and kept up to date. At only one place has a comprehensive survey been made, and this was the investigation of a reported shoal. Arrangements have been made to take up the survey of the entire area in July, 1919.

30. *Chesapeake Bay and tributaries.*—These have been extensively surveyed in recent years, and a large number of tributaries will not require resurveys for many years. This is also true of the Potomac River. The parts which need resurveying are parts of the bay from Cape Charles to a point opposite Annapolis, parts of the James River, and the Rappahannock and Susquehanna Rivers. The entrance has been recently surveyed, but another survey will probably be needed in 10 years. The bay is greatly in need of examination at critical localities where depths are near the draft of vessels; frequent reports indicating presence of new shoals.

31. *Chesapeake Bay entrance to Cape Hatteras.*—The diagram shows the tracks for both the light-draft and deep-draft vessels. While a resurvey is desired, the most pressing need is that the present limit of shoal areas be accurately determined.

32. *Albermarle Sound.*—Albermarle Sound and its tributaries, with a few exceptions, have been resurveyed within the last few years and will not require resurveying for a long time. The uncompleted portions, including the North and Alligator Rivers, should be finished in the near future, as they form part of the project for a through 10-foot channel of the inside waterway route. The Chowan River, which is the western extension of the sound, should also be finished, and then the surveys of this region would be in a most satisfactory up-to-date condition.

33. *Croatan Sound.*—Croatan Sound, the connecting link between Albemarle and Pamlico Sounds, has recently been resurveyed, but the depth is so near to the draft of vessels using it that the surveys will have to be revised from time to time. Changes in the main channel have occurred within the last two years.

34. *Pamlico Sound.*—Pamlico Sound has additional importance owing to its relation to the inland waterway route. The eastern half of the sound is well surveyed, but the entire western half and the Neuse River, which, in addition to its local use as part of the through 10-foot channel, have not been covered by recent surveys.

35. *Diamond Shoals.*—Diamond Shoals off Hatteras should be resurveyed chiefly to determine changes in their extent, and particularly to obtain a knowledge of the correct depths on the seaward side.

36. *Cape Hatteras to Winyah Bay, S. C.*—Nearly the whole of this area is in need of a new survey, as those now charted are not in sufficient detail for modern navigation. Next to Diamond Shoals in importance to coastwise navigation are the shoals extending seaward from Cape Lookout and Cape Fear. They are subject to change and should be examined at short intervals.

37. *Winyah Bay to Fernandina, Fla.*—From Winyah Bay to Fernandina, Fla. This region has been recently surveyed, the work extending out to the 100-fathom curve.

38. *Fernandina to the Florida Reefs.*—From Fernandina to the Florida Reefs the area of moderate depths continually narrows, until at Palm Beach the distance to the 100-fathom curve is very small. The completed survey extends southward to a little below St. Augustine. South of St. Augustine, the bottom is probably not subject to change except as noted below, and the surveys, while by no means complete, are fair. Off Cape Canaveral and outside the southern half of the Indian River there are extensive banks and ridges in urgent need of resurvey. Known depths of 11 to 16 feet a long way offshore show the need of further surveys to make certain that all the shoals are correctly charted. From Jupiter Inlet to Fowey Rocks, where the Florida Reefs begin, the deep water approaches so close to the shore that it will be a slight task to complete inshore work in connection with the offshore surveys.

39. *General, Atlantic and Gulf coasts.*—An explanation of the method used in locating a vessel by sounding will show why accurate charts are particularly needed from New York to Palm Beach and from Key West to the Mexican border. At fixed intervals the vessel takes soundings, which are plotted to the scale of the chart on tracing paper, and this is moved over the chart, keeping the line joining the soundings parallel to the course of the vessel until the soundings agree with those shown on the chart. If the charts are correct and based on a sufficiently modern survey, the method is one of the best known for locating its position. If, on the other hand, the soundings are few and far apart so that the ship's soundings fall between them, and if those on the chart are wrongly placed, this method becomes much more difficult and an accidental agreement may lead the vessel into danger. From New York to Cape Hatteras the charts are fairly good, by no means good enough to meet the full needs of navigation, but the work required to bring them up to date has been postponed, as the need for resurveys has been more urgent farther south. Up to a few years ago the offshore surveys from Cape Hatteras to the Florida Reefs were almost unbelievably deficient. This condition is being remedied as rapidly as possible, and between Winyah Bay, S. C., and St. Augustine, Fla., the offshore work out to the Gulf Stream is complete. It is important that this work be extended both north and south from its present limit as rapidly as possible. With adequate funds full advantage can be taken of the seasons and by working north in the summer and south in the winter the cost of the work will be greatly reduced.

40. *Indian River.*—There have been no recent surveys of these waters. Revisionary work is needed.

41. *Biscayne Bay.*—Recent surveys have been made of this area. In the vicinity of Miami and as far south as Fowey Rocks.

42. *Vicinity of Fowey Rocks Light.*—No recent surveys have been made. Inshore and offshore work is needed. The present surveys are not sufficient in detail.

43. *Coast of Florida from Palm Beach around to Cedar Keys.*—For a distance along the shore of 567 miles from Palm Beach southward around to Cedar Keys on the west coast of Florida, coral reefs are found, in some places more abundant than in others. Coral reefs, whether the result of disintegration or of a building up by animal growth, are found in a great variety of forms and in vast numbers of sharp projections from the general bottom where conditions are favorable for the growth of coral. While we are informed that an enormous number of uncharted rocks exist in this region, the fact that they are so numerous, that the region is so large, and that there is little navigation over much of it, it appears to the interests of navigation to drag areas of the coast used by commercial and naval vessels, because of both the time and cost involved. Wire-drag work is accordingly undertaken in localities where there are commerce and naval operations. To accomplish even this will require years of work. Westward-bound vessels through the Florida Straits have to force their way against the strong current of the Gulf Stream, which in places attains a velocity of 5 miles per hour. Along the northerly edge of

the stream and close to the reefs the current is very weak and at times runs to the westward. There is a strong temptation to keep dangerously close to the reefs and save fuel, and this is the cause of frequent accidents. Besides the danger of running into the known reefs, which are in many places bare and are of no great depth throughout their length, another danger, the extent of which is not yet known, has been discovered in a secondary reef, parallel to the main reef, and about one-half mile outside of it. This secondary reef is found to approach the surface in places as a narrow ridge with depths as little as 25 feet. Twenty-five miles of this reef has been examined, but 200 miles remain to be examined. It is important to nearly all the great traffic entering the Gulf of Mexico that this examination be completed at the earliest possible moment.

44. *Vessel courses north from Key West.*—Vessels bound for eastern Gulf ports naturally wish to take the shortest route. If of light draft, they can cross the Florida Reefs at Key West. The next channel is between Rebecca Shoal and Dry Tortugas, and if this is not used vessels must pass well to the westward of Dry Tortugas to avoid a shoal bank west of it. The Rebecca Shoal channel has been dragged and has ample depth of water. The bank west of Tortugas should be dragged, especially as vessels making land from the westward have to cross part of it. Northward of the keys from Key West to Tortugas a doubtful area should be dragged. The channel between the keys and the reef known as the Hawk Channel is important for moderate-draft vessels. While it is not at present planned to drag it, it may be found necessary to drag the axis of the channel.

45. *Cape Ramano.*—This area is in need of surveys.

46. *Charlotte Harbor.*—No recent surveys have been made of this area and should be resurveyed.

47. *Tampa Bay and approach.*—The existing surveys at present meet the needs of navigation of these waters.

48. *Cedar Keys.*—No recent surveys have been made of this region. Wire-drag surveys are badly needed.

49. *Apalachee Bay.*—No recent surveys have been made of this region and revision work is needed.

50. *Inshore waters, Gulf coast.*—The chief characteristics of the west coast of Florida are the distance to which shoal water extends offshore between Cape Sable and Cape Romano and from Tampa Bay to Apalachicola, and the existence of a number of large bays connected with the sea by deep channels, either natural or dredged. From Apalachee Bay to Cape San Blas the coast begins to assume a character more like the South Atlantic coast, and coral bottom is no longer found. This stretch of coast is sandy and sand shoals extend off some distance, especially in the vicinity of Cape San Blas. This region needs a resurvey and, like other sandy portions of the coast, will need resurveying from time to time. The Florida and Alabama coasts are somewhat different, as deep water approaches close to the shore in the latter. The coast of Mississippi and Louisiana has a very large proportion of changeable area, and resurveys

are needed now and will be needed from time to time in the area from Mobile Bay to the end of the offshore shoals of Vermilion Bay. The immense load of sediment carried by the Mississippi River, especially in time of flood, causes constant changes in the delta. The deposit of sediment and the action of the waves on the deposit results in rapid growth in some places and of erosion in others. Sixty miles west of the Mississippi Delta there begins an extensive shoal region which is in need of survey. The inshore portion along the rest of the Louisiana coast, and the Texas coast, with an important exception, has deep water fairly close to the shore. The exception is along the eastern part of the Texas coast from Sabine Pass to Galveston. Sabine Bank and Heald Bank have shoal depths at a considerable distance from the shore, and they should have a thorough resurvey. Galveston Bay also needs resurveying.

51. *St. Josephs Bay.*—No recent surveys have been made of this area and a reexamination is needed.

52. *Offshore waters, Florida reefs to the Mexican border.*—Along the northern edge of the Florida Straits the soundings are insufficient, and they will have to be carried out somewhat beyond the 100-fathom curve. Along the west coast of Florida the distance out to the 100-fathom curve is about 100 miles. Over much of this area the depths are moderate and the charts are based on reconnoissance surveys only. The bottom is coral rock in many places, and projections from coral banks may come sufficiently near the surface to be a menace to navigation. Fishermen have reported several uncharted ridges, and while the somewhat incomplete surveys of the reported localities have not confirmed all the details of their reports, important differences from the charted depths have been found. The 100-fathom curve approaches fairly close to the Mississippi Delta, then swings offshore again, so that it is about 60 miles south of Sabine Pass. It then swings to the southward in a curve, which brings it within about 80 miles offshore at the Mexican border. This whole offshore area is badly in need of a thorough resurvey. There is no other part of the work in offshore water so likely to be productive in furnishing important changes in existing charted depths.

53. *Pensacola Bay.*—Surveys are now under way at the entrance to the bay; the entire bay requires reexamination.

54. *Mobile Bay.*—A resurvey of this bay has been completed.

55. *Mississipi Sound.*—A resurvey of this sound has been completed.

56. *Lake Pontchartrain.*—In connection with the surveys in Mobile Bay and Mississippi Sound, a recent survey has been made at the eastern end of the lake. The greater part of the lake has not been examined for 20 years.

57. *Approaches to Mississippi passes.*—Resurveys have been completed recently.

58. *Vermilion Bay and Cote Blanche.*—No recent surveys have been made of these areas. Surveys are needed.

59. *Approach to Sabine Pass.*—No recent surveys have been made here and revisionary surveys are needed.

60. *Porto Rico.*—The surveys of Porto Rico were begun when the island came under the jurisdiction of the United States as a result of the Spanish-American War. By 1910 the surveys of the bays, channels, and inshore waters were completed and a number of deep-sea soundings were taken around the island. There are, however, extending to the eastward and westward of the island and along the south coast extensive areas where the bottom is of coral formation. There are also reefs along the north coast, but as they are close to shore and must be avoided by vessels, it is only important to know their location and limits. The areas on the east, south, and west are different in that there is traffic between the reefs and over areas where the depth is little greater than the draft of the vessel, and the probable existence of uncharted projections is a source of danger. Vieques Sound between Culebra and Vieques Island, east of Porto Rico, Virgin Passage, and the approaches to the harbors of the American Virgin Islands are in need of wire-drag surveys. The only work of this character that has been accomplished here is in the vicinity of Mayaguez. This work resulted in the abandonment of one channel and the rebuoying of another.

61. *Virgin Islands.*—The Virgin Islands were purchased from Denmark, and the United States took possession in 1917. The surveys that have been made are by the British and Danish Governments. At the present time the available data regarding these surveys are being examined with the view to determining whether or not they are sufficient for the needs of our naval and commercial vessels. It is certain that the coral formation in the waters touching these islands requires extensive wire-drag surveys before accurate charts can be issued.

62. *Panama Canal.*—The Atlantic approach to the Panama Canal has been surveyed since work started on the canal construction. Limon Bay is, however, a region where pinnacle rocks occur. All the anchorages should be dragged, and the work should be carried a short distance outside. The Pacific approach to the canal has had a recent survey and has been dragged. No further surveys are needed at the western end at present.

63. *Pacific coast of the United States.*—The western coast of the United States is very different from the eastern. Generally mountainous, with comparatively few harbors or inside waterways and with comparatively deep water close to the shore, it presents little resemblance to the low shores and wide continental shelf of the Atlantic. The purpose of the surveys is, then, to meet the needs of vessels approaching from seaward and coasting vessels which keep to a few comparatively narrow tracks, to insure up-to-date charts of the various harbors, to make soundings offshore, and to develop fishing banks that are known to exist. The weather is an important factor in increasing the importance of the charts of this coast. From Los Angeles Harbor northward fog is very common in the summer time, and in the winter gales accompanied by thick weather are of frequent occurrence. On the coast in the vicinity of San Francisco thick weather is of frequent occurrence. On the coast in the vicinity of San Francisco thick weather is prevalent for perhaps 25 per cent of the time. Under such conditions the navigator must rely entirely

upon his chart, and it is essential that detail surveys be made to beyond the limit of soundings taken by merchant vessels, which is the 100-fathom curve. Along the shore of southern California much work was done up to 1895, and some of the surveys then made may be accepted as final. In the vicinity of the outer islands surveys extended only a little way from the shore, and the deep waters between and outside of them are surveyed. The few soundings taken show irregular bottom and breakers have been reported in places where the chart shows 600 fathoms. These waters, therefore, should be surveyed out to the 1,000-fathom depth. The Oregon coast is practically unsurveyed. A limited amount of work was done years ago south of Cape Blanco and in the vicinity of the Columbia River, but this was not more than a reconnoissance and does not extend out far enough to be of practical value to navigators. Elsewhere no surveys have ever been undertaken. Even in such an important locality as Cape Blanco, which must be rounded by all vessels plying between the Columbia River and San Francisco, there are no soundings to serve as a guide in thick weather, and vessels have been lost wholly on account of this lack of surveys. On the coast of Oregon there are eight important harbors on which the Government and private interests have expended approximately $40,250,000 in improvements designed to facilitate navigation. One of these is the Columbia River, the gateway to one of the most important transportation centers of the Pacific coast. Yet in spite of these immense expenditures for improvement, there is not a single one of these harbors the approaches to which have been adequately surveyed. The approaches to the Columbia have been sounded for a short distance offshore, but even in this area the soundings are too far apart to more than indicate, in a general way, the depths which may be expected. This partial survey extends southward along the coast to include the approaches to two other harbors. The approaches to the remaining five, on which $3,826,000 have been expended in improvement, are entirely unsurveyed. The entire Washington coast stands in urgent need of a first survey, except in the approach to the Straits of Juan de Fuca and in the straits themselves where the present work is adequate.

64. *Los Angeles Harbor.*—Los Angeles Harbor should be dragged.

65. *San Francisco Bay.*—San Francisco Bay is of varied character of bottom and the needed surveys vary to correspond. The outer approaches are complete except in the vicinity of the Farallones. Here additional sounding is needed and an investigation should be made with the wire drag to verify the existence of other rocks than those charted. The bar outside the Golden Gate needs a resurvey. Wire-drag work has been carried through the Golden Gate and inside, both northward and southward of San Francisco to the limit of the rocky area. The southern part of the bay where the bottom is subject to change by currents is in need of resurvey.

66. *Along shore waters of the Pacific Coast States.*—From the western end of the Santa Barbara Channel to Monterey Bay the surveys, as a rule, extend only to the 50-fathom curve, which lies but a short distance offshore. These surveys should be extended seaward to include the usual track of coastwise vessels, which lies an

average distance of about 10 miles from shore. From San Francisco Bay to Point Arena a widely-spaced system of sounding lines has been carried out to the 100-fathom curve. Here, an additional amount of work, about equal to that already accomplished, is necessary before the survey can be considered complete. Between Point Arena and Cape Mendocino the surveys extend a uniform distance of 6 miles from shore, reaching depths varying from 50 to 200 fathoms. Additional detailed surveys should be made in the vicinity of each cape, and between them the work should be carried seaward to beyond the steamer track. From Cape Mendocino northward to the Oregon boundary the limited surveys existing were made many years ago and are entirely inadequate. A complete resurvey should be made at the earliest possible date. There are no adequate surveys of the inshore area along the State of Oregon. Of the water off the northern part of the Pacific coast, little is known except that the Bureau of Fisheries, acting on the information obtained from fishermen, has located certain banks. These banks should be surveyed to determine their depths and extent, and it is believed that a general survey carried out to the 1,000-fathom curve will result in the discovery of other banks of great value.

67. *Interior waters of the State of Washington.*—The interior waters of the State of Washington represent the point of change from a practically straight coast line to the broken formation of the coast of British Columbia and southeastern Alaska. There are many channels of importance leading to Seattle, Tacoma, Everett, Bellingham, and Olympia, and connecting with the inside passage to southeastern Alaska. All these waters should be dragged wherever there is the slightest doubt as to the presence of dangers to navigation.

67a. *Alaska, general.*—An important difference between Alaska waters and those of the continental United States is that scarcely enough work has been done to let us know just how much must be done to complete the charts. The development of the country has far outstripped the progress of surveys, not only because of the few vessels and parties engaged in the work, but because of the great length of coast over which the various activities are scattered and the intricate system of channels for so much of its extent. In order to appreciate the need of rapidly extending the surveys of these waters, it should be clearly understood that Alaska's only connection with the rest of the world is by the water routes. The amount of the natural resources of Alaska ripe for exploitation has been so great and the prize they offered so tempting that transportation could not wait for the Government to make the way to them secure. It has gone ahead finding its own path to new fields, suffering great losses in so doing, but content to suffer them because the returns were so immensely greater.

68. *Steamer routes, southeastern Alaska.*—In southeastern Alaska the first and most obvious need is to complete the wire-drag work. Most of these waters have been sounded, so that only dragging is necessary to complete this survey. This drag work should be taken up in the order of its importance, beginning with the main steamer route through the region and then taking up the various tributary waters leading to areas of commercial importance. For some years past, two parties have been actively engaged in dragging the main steamer routes, and this work is now about 55 per cent complete.

69. *The outside coast waters of the islands bordering on the open Pacific.*—These and their connecting channels are largely unsurveyed and should be navigated with great caution. A navigator, seeing a chart on which the shore line is stretched, no soundings, several rocks and shoal banks, notes as to rocks and breakers reported, and a statement on the chart to the effect that the area is unsurveyed, is, to say the least, unable to proceed with confidence; and this situation is by no means unusual. The same pressing need of such regions is a complete hydrographic survey followed later in places by wire-drag work. The rapidly increasing commercial importance of this region and the exceptionally dangerous character of the waters through which traffic must pass, render surveys in the near future imperative.

70. *Cross Sound to Prince William Sound.*—From Cross Sound, the northernmost channel from the inside waters to the sea, to Prince William Sound, the coast has few features of present or prospective importance. There is, however, urgent need for surveys to insure the safety of vessels approaching and passing along this coast. In this region the charts are very defective in the manner of showing sounding and prominent coastal mountain peaks and headlands that would enable the navigator to obtain his position on approaching from seaward. The only important break on this coast, Yakutat Bay, has some canneries, and additional surveys are needed here on this account.

71. *Prince William Sound to Unimak Pass.*—A very important section of the Alaska coast extends from the waters of Prince William Sound westward to Unimak Pass. Not only are the industries of present importance, but there are extensive mineral resources largely undeveloped through lack of cheaper transportation. The point to be emphasized is that this is not an old, settled country with its needs in the matter of transportation fixed, but it is still capable of great future development, and in considering the needed surveys its future must be taken into account. The approaches to Prince William Sound have been surveyed and no resurveys for the present are needed except in the vicinity of Cape St. Elias and Middleton Island. Wire-drag work will be needed in both of these localities as reefs and pinnacle rocks exist. Prince William Sound needs additional soundings over most of its area, and many of its branches need original surveys. Cordova is the terminus of the Copper River & Northwestern Railway which gives access to the important copper mines on the Copper River. The approaches to Cordova have been surveyed, except for wire-drag surveys needed to insure complete safety. Seward, on Resurrection Bay, is the terminus of the Alaska Railroad now being built by the Government. The surveys of its approach are completed except for wire-drag work. It is probable that much of the trade originating along the line of the Government railway will be transshipped at Anchorage at the head of Cook Inlet. Not only will this make it necessary for many vessels to navigate these waters, but there are now very large salmon canneries all along its shores, as well as considerable mining. The present surveys are inadequate and wire-drag work is needed over much of its area.

Kodiak Island, with a number of canneries and with some cattle grazing, is largely unsurveyed. From Kodiak Island westward to Unimak Pass only a comparatively small part has been surveyed at all. While the amount of present traffic is small it is sufficient to need protection. At present the Coast Guard vessels and the freight and passenger vessels run grave risks in using the protected natural channel leading along the coast inside the island. This is a particularly bad stretch of coast with many reefs and islands. Only in the vicinity of the Shumagin Islands and from Unimak Pass to Unalaska Islands have surveys been made, and they are inadequate. It is not now practicable to drag the entire area, but it is important that the immediate needs of navigation, even though of limited amount, be met by dragging a selected channel to insure the safety of vessels from Shelikof Strait to Unimak Pass. Unimak Pass is the almost universally used channel into Bering Sea. It has been surveyed, but it is probable that part of it should be dragged or at least further soundings be taken.

72. *Aleutian Islands.*—The Aleutian Islands have comparatively little traffic and are without survey. It is necessary that this region be patrolled by Coast-Guard vessels. The loss of one of the vessels of this service a few years ago was wholly due to the lack of adequate surveys.

73. *Bristol Bay.*—A large part of the salmon shipped from Alaska comes from Bristol Bay. This is without surveys except in Nushagak Bay and Kuskokwim Bay and River. Both of these have recent surveys, but as the bottom is subject to change on account of the large rivers, future additional surveys will be needed. As an example of what surveys mean in a new region, the discovery of an entrance to the Kuskokwim River suitable for moderate-draft vessels opened up an immense area for grazing and also in places for general agriculture.

74. *Norton Sound.*—The importance of Norton Sound is due to the gold mining on its northern shores and as being the outlet of the Yukon delta on the southern shore. In all of Norton Sound additional surveys are needed. It is curious that in this sound, which according to all available information is of quite level, sandy, or muddy bottom, Besboro Island rises very abruptly to a height of 1,012 feet. With such an occurrence it is not absolutely certain that no pinnacle rocks exist.

75. *Bering Sea and Arctic Ocean.*—Except in the vicinity of Pribilof Islands, there are no other existing surveys in Bering Sea or to the north which can be considered of value.

76. *Guam.*—The present chart of the island of Guam is compiled from Spanish and British charts and some harbor surveys by the United States Navy. No attempt at a comprehensive survey has been made. A complete survey should be made, not only including the harbors, but the surrounding waters, carrying the work out to a depth that will be certain to include all dangers. In these waters shoals rise abruptly from great depths, and the absence of soundings on the charts does not imply safety, but simply absence of surveys.

77. *Hawaiian Islands.*—There are only two good harbors on all the Hawaiian Islands and both of these are on Oahu Island. All of the islands except Hawaii have coral reefs around at least part of

them. In the vicinity of Oahu, Maui, Kahoolawe, and the south coast of Molokai the surveys are fairly complete. In the vicinity of Hawaii the surveys are very inadequate except in the only harbor, Hilo Bay. The west coast of Lanai and the vicinity of the two westernmost islands, Jauai and Niihau, are practically unsurveyed. The various channels between the islands from Maui to Oahu are fairly well surveyed. The others are practically without surveys.

78. *Philippine Islands.*—The Philippine Islands are composed of not less than 3,000 islands and islets covering an area of approximately 150,000 square miles, about the same as that of the five New England States and the State of New York combined. The total length of the general coast line, measured on small-scale charts using 3-mile spaces of dividers and omitting islands and bays less than 3 miles long, is approximately 10,850 miles, or about the same as that for the entire Atlantic coast of the United States, including the islands. About 75 per cent of this shore line has been completed. The unsurveyed hydrography covers a large area on account of the necessity of extending this work, in some localities, for many miles offshore, and on account of the very extensive area of the Sulu Sea. It is estimated that about 50 per cent of this class of work has been completed. The unsurveyed regions are as follows: The northeast coast of Luzon from Polillo Island northward to Aparri; the region off the north coast of Luzon, including the Babyan Islands, Balintang Channel, the Batan Islands, and Bashi Channel; the entire west coast of the island of Palawan, the west coast of Mindanao, from Blanca Point south to Zamboanga; the south coast of Mindanao, from Pola Point to Malita, in Davao Gulf; the Sulu Archipelago and the Sulu Sea from Cuyos south to the limit of our possessions off the coast of Borneo.

79. *Northeast coast of Luzon.*—This entire unsurveyed region, from Polillo Island on the south to Aparri on the north, is of little commercial importance, and being quite free from dangers to navigation, the execution of the work is being delayed until more important localities are completed. Little reliable information relating to this region is available, but a number of good anchorages have been reported. Among these are the inner harbor of Port San Vincente, Dilasac Bay, Casiguran Sound, and Dingalan Bay. The first and third mentioned are excellent typhoon harbors. The work must, however, be done during the season of frequent typhoons, it being impossible to approach the coast at any other time of the year on account of the heavy sea caused by the northeast monsoon.

80. *Off north coast of Luzon.*—A survey should be made of the islands and the waters to the northward of Luzon as far as Bashi Channel, as, in accordance with the numerous reports, there is considerable uncertainty in regard to the true location of the islands and the rocks that are dangerous to navigation in the locality. As it is in the region visited by frequent typhoons, the work should be undertaken during the period when the typhoons are less frequent.

81. *West and east coast of Palawan.*—The coast line of the island of Palawan is very irregular, indented with deep bays forming some

of the finest harbors in the Archipelago. The whole region about the island and extending southward to Balabac Island, Banguey Island, to Cagayan Sulu, and off the north coast of Borneo consists of coral reefs, many small islets, and innumerable hidden dangers to navigation. To the westward of Palawan, reefs and dangers extend to over 100 miles offshore. The hydrographic survey of this region involves an immense amount of labor. A preliminary survey for the location of channels through the reefs and entrances to harbors will first be necessary, after which these localities must be swept with the wire drag.

82. *West coast of Mindanao.*—The necessity of the survey of this unfinished portion of Mindanao, from Blanca Point to Zamboanga, a stretch of about 150 miles, is not urgent, as the region is of no commercial importance and is considered to be free from dangers to navigation. The coast is bold and rocky, exposed to both the northeast and the southwest monsoons, and there are only a few months in the year before the change in the monsoons that are favorable for work in this region.

83. *South coast of Mindanao.*—This stretch of about 160 miles, from Pola Point to Malita in Davao Gulf, involves no great difficulty. The coast, in general, is bold and steep with numerous outlying reefs which, however, do not extend a great distance from shore.

84. *Sulu Archipelago.*—This region, about 75 miles wide, extending in a southwesterly direction from Zamboanga on the southern coast of Mindanao, to the coast of Borneo, a distance of about 180 miles, has scattered over it about 300 islands and islets and numerous hidden dangers to navigation. It requires a survey of the most careful and intricate character, and much of the locality must be swept with the wire drag. The formation is coral and dangerous to navigation, as rocks are frequently found in localities where they are least expected to exist. The currents in the region are very strong. The physical conditions are such that excellent control to coordinate the work with that along the coast of Mindanao can be obtained.

85. *Sulu Sea.*—The northern end, as far south as the Tubbataha Reefs, except certain small areas, has been surveyed with a fair degree of accuracy, but owing to the coral formations, where hidden dangers frequently exist, wire-drag sweeping will be necessary in selected passages. The entire region to the south of the Tubbataha Reefs remains unsurveyed except for a reconnoissance with approximate locations by navigational methods. Numerous rocks and reefs dangerous to navigation are scattered throughout the sea, but certain well-defined passages have been examined with sufficient accuracy to make navigation through them reasonably safe.

## GEODETIC SURVEYS.

The foregoing is a general review of the condition of our hydrographic survey. A general discussion of the condition of our geodetic survey follows.

It has been the purpose of the Coast and Geodetic Survey for some years to extend its geodetic work so as to have control available for all Government, State, city, and private engineers and surveyors.

There are many cities to-day whose maps will be placed on the wrong datum with respect to both elevations and positions as a result of the lack of primary triangulation and precise leveling in the interior of the country. Every city of any size and every State of the Union should be furnished by the Federal Government with the fundamental control of which can be based surveys and maps of detailed character in any particular locality.

It is difficult to overestimate the necessity of having a proper amount of horizontal and vertical control in this country for the use of map makers, surveyors, and civil engineers. For this purpose triangulation and precise leveling bench marks should be placed within 50 miles of each place in the United States. With the Federal control carried to this extent it would be a very simple matter in the future to have detailed control placed in many areas just ahead of the surveyors and engineers who are to make the surveys and maps. This main control should be extended as rapidly as equipment and personnel of the Coast and Geodetic Survey will permit, and say, within five or six years, should be practically completed as far as the main part of the work is concerned.

It is, of course, difficult to give exact figures to show how much leveling and triangulation will be needed to finish the minimum that is essential, because plans must be changed from time to time to meet the need of the topographic engineers, but it is reasonably certain that the primary triangulation and precise leveling which should be done within the next five years will cost about $1,725,000. It is therefore believed that Congress should be asked to furnish for the geodetic work one-fifth of that amount each year, or about $345,000 per annum. With this distance of 50 miles as a criterion it can be seen that lines of precise leveling and arcs of primary triangulation would be approximately 100 miles apart. When it is considered that this distance is equal to that between Philadelphia and Baltimore or Philadelphia and New York is it realized that this is not an excessive amount of control. This estimate of fundamental control is made with a view to covering all of the country with a fair distribution of the control and later to filling in the intermediate areas as the demands of surveyors and engineers arise.

The amount of geodetic control in the United States at the present time is as follows:

| | Miles. |
|---|---|
| Primary triangulation | 14,000 |
| Primary traverse | 2,000 |
| Precise leveling | 41,000 |

The amount of control to be executed to bring the horizontal and vertical control within 50 miles of any place in the United States is as follows:

| | Miles. |
|---|---|
| Primary triangulation and primary traverse | 17,000 |
| Precise leveling | 30,000 |

We have many needs for accurate control and accurate maps. The principal one of these is probably for Federal, State, city, and highway engineers. There will be hundreds of millions of dollars spent each year in the United States in building new roads and in maintaining and improving old ones. It is reasonably certain that this road work could be done at a considerable saving if the country through which the road work is carried on were properly mapped. The total cost of mapping the country topographically will be not more than $100,000,000, and this is the amount which will be spent on roads every three months for probably 10 years. It would certainly be good policy to have the maps precede the building of roads rather than to have them follow.

It is planned to have primary triangulation done during the next year in Oklahoma, New Mexico, Arizona, California, Colorado, Oregon, and Idaho.

Leveling should be done now in Utah, Colorado, New Mexico, Texas, Wyoming, Montana, Arizona, Iowa, and Wisconsin.

Astronomic work is to be done in the States where primary triangulation is done.

Gravity work will be done principally in Texas, Oklahoma, Missouri, Kansas, and Nebraska.

The magnetic work of the Coast and Geodetic Survey has grown out of the practical needs of the navigator and the surveyor. With the development of long-distance aviation, the demands of the aerial navigator are added to those of the ocean navigator.

The ultimate object of the survey of the coast of a country is the construction and distribution of charts showing the hydrographic and topographic features and other information needed by the mariner for the safe navigation of the adjacent waters. When no landmarks or heavenly bodies are visible, the navigator must depend upon the compass to guide him on his way. Unfortunately the compass needle does not in general point due north nor is its direction at any particular place constant. In the United States, for example, the compass points 22° west of north in the northeastern part of Maine and 25° east of north in the northwestern part of Washington. In Porto Rico the compass needle now points 1° 30′ more to the west than it did 10 years ago. It is evident, therefore, that a knowledge of the variation of compass or the magnetic declination, as it is better to call it, is one of the essential features of a chart, and in order that a chart may be serviceable for a number of years it must give not only the declination at some particular date, but also the rate of change.

Nearly all of the original land surveys of the United States were made by compass, and the boundaries in the deeds were defined by compass bearings. With the lapse of time, land values increased and controversies arose as to the location of boundary lines which had not been marked or of which the markings had disappeared. In order to retrace the lines of a tract of land surveyed originally by compass, the surveyor must know the change in the direction of the compass needle; that is, the change in the magnetic declination between the date of the original survey and of the resurvey. To meet the demand for information of this kind the Coast and Geodetic Survey took up the study of the secular change of the elements of the earth's magnetism and of the magnetic declination in particular. A collection was made of all the available results of magnetic observations in the United States and a few foreign countries, paying particular attention to results at places where observations had been made more than once. Observations were made from time to time at many of these "repeat" stations in order to keep the secular change data up to date. From a discussion of all the available material and a comparison with similar data for places in Europe at which more extended observations had been made, it was possible to prepare tables giving the secular change of the magnetic declination in all parts of the United States from the time of the earliest observations, tables which have many times stood the test of comparison with the observed changes of bearings of well-defined boundary lines, with the result that the Coast and Geodetic Survey has come to be recognized as ultimate authority in land-boundary controversies involving the secular change of the magnetic declination.

In view of the difficulty experienced in attempting to retrace the lines of old compass surveys, accentuated at times by instrumental errors due to imperfect construction or lack of proper care, it became important to guard against a similar condition regarding present-day compass surveys, by determining in as great detail as available funds would permit, the distribution of the magnetic declination throughout the country and in secular change, at the same time providing local surveyors with meridian lines or other means of testing their compasses.

The importance of a magnetic survey of the country to meet these needs was recognized at the time of the reorganization of the Coast and Geodetic Survey in 1843, but it was not until 1899 that the necessary funds became available for taking up this work systematically. The plan for the magnetic survey for the United States, as laid down in 1899, provided for a first general survey with stations 30 or 40 miles apart, to be followed by a more detailed investigation of regions where the general survey indicated irregular distribution of the earth's magnetism. The plan also included the reoccupation at intervals of five years of a sufficient number of "repeat" stations to determine the change of the magnetic elements with lapse of time, and the operation of magnetic observatories for determining in more detail the changes in the direction and intensity of the earth's magnetic field, and the accumulation of the data needed for the study of the nature and cause of the phenomenon.

Following this general plan, the distribution of stations has been made largely upon the county subdivisions of the States, the idea being to have one magnetic station in each county so that the necessary data might be available for the use of the county surveyors in testing their compasses. With this end in view, most of the stations have been marked in a permanent manner and true bearings of prominent objects have been determined. In many cases meridian lines have been established for greater convenience of the local surveyors. Observations have been made at all but about 130 of the county seats and a number of areas of marked local disturbance have been examined for detail. The density of the distribution of the stations corresponds in a general way with the density of the population, so that in the unsettled and less accessible portions of the country they are widely scattered, but for the whole United States the average distance between stations is 25 to 30 miles. About 75 repeat stations a year have been occupied. Magnetic observatories have been in continuous operation at Cheltenham, Md., since 1901;

at Sitka, Alaska, and near Honolulu, Hawaii, since 1902; Vieques, P. R., since 1903; at Baldwin, Kans., from 1900 to 1909; and near Tucson, Ariz., since 1909.

In Alaska the magnetic survey has gone on in conjunction with other branches of the work of the Bureau, so that the observations have been for the most part confined to the seacoast, except for a series of stations along the Yukon River, and a series of observations secured by the parties surveying the one hundred and forty-first meridian boundary line. A general magnetic survey of Porto Rico, Hawaii, and the Philippine Islands has been completed and some observations have been made in Guam and on the Canal Zone.

In the United States proper there still remain many locally disturbed areas which require investigation, the extent to which the investigation should be carried in any particular case being a question which can not be determined in advance. There are other regions where more stations will be required as they become settled. In addition, in order that the accumulated results may continue to be of use, observations at repeat stations must be kept up regularly.

Most of the leading nations of the world are cooperating in a study of the earth's magnetism, in an effort to determine its origin, the cause of its many fluctuations, and the laws which govern them. Some of these fluctuations require a long term of years for their full development. In order that accurate data may be available for these investigations, therefore, many magnetic observatories must be kept in continuous operation, recording every change in the direction and intensity of the earth's magnetic field. As the changes are found to be different in different parts of the earth, it is important to have the observatories as widely distributed as possible. The United States, by reason of its wide extent of territory, is very favorably situated for carrying on a large share of this work, and the sites of the five magnetic observatories now in operation were chosen with this object in view. With the addition of observatories in the Canal Zone and on the island of Guam we should have a chain of stations extending nearly halfway around the globe from longitude 65° to 216° west, and extending from latitude 9° to 57° north. These would be supplemented by the observatory near Manila, P. I., now being maintained by the Jesuits.

# Part III.—WAR WORK OF THE BUREAU.

## SUMMARY OF WAR WORK OF THE BUREAU.

This Bureau bore an important burden during the war, both in the field and in the office. All told, 272 men, drawn both from the field and the office, took part in the war. These were drawn from all ranks of our employees, ranging from the Superintendent of the Bureau to temporary hands employed by the field parties of the Bureau. In our report for 1918 we gave a list of those from this Bureau in the War Department and in the Navy Department with their ranks, but as some of them had attained higher ranks by the close of the war, it seems proper to again repeat the list giving the now correct ranks. In my report for 1918 I gave the names only of those who were commissioned either in the Army or the Navy. For the purpose of making a permanent record, I shall herein include in alphabetical order, showing their rank so far as we have the information, all of the men who served in either branch of the military service, from this Bureau. The list follows:

Adams, Kenneth T., Lieut. (j. g.), Navy.
Akerstrom, O. R., Seaman, Navy.
Alber, Amado, Seaman, Navy.
Albang, B., Seaman, Navy.
Anderson, G. E., Seaman, Navy.
Angelo, John A., Pvt., Army.
Aven, W. R., jr., Pvt., Army.
Bacchus, A. W., Seaman, Navy.
Bales, A. W., Pvt., Army.
Bargmann, F. H., Seaman, Navy.
Barker, Stanley T., Lieut., Navy.
Bartlett, Harrison R., Lieut., Navy.
Bean, George L., Lieut. (j. g.), Navy.
Belcher, J. R., Pvt., Army.
Bennett, R. K., Second Lieut., Army.
Bilby, W. J., Pvt., Marines.
Blas, Pabon, Seaman, Navy.
Bolles, C. M., Pvt., Army.
Borden, F. S., First Lieut., Army.
Bowie, Wm., Maj., Army.
Bowman, A. L., Pvt., Army.
Braden, Mart, Pvt., Army.
Brittingham, C. B., Seaman, Navy.
Brookbank, J. S., Pvt., Army.
Brown, Dave, Pvt., Army.
Brown, G. S., Seaman, Navy.
Brown, R. M., Pvt., Army.
Buckley, R. J., Pvt., Army.
Bullock, J. H., Pvt., Army.
Bush, Harold, Pvt., Army.
Bussell, Conrad T., Lieut., Navy.
Bussey, W. R., Pvt., Army.
Caldwell, W. B., Seaman, Navy.
Callis, D. S., Seaman, Navy.
Campbell, Andrew, Pvt., Army.
Carey, William P., Seaman, Navy.
Caron, W. H. J., Seaman, Navy.
Carothers, Pvt., Army.
Casbeer, George, Pvt., Army.
Cassedy, Miller A., Pvt., Army.
Castles, P. B., First Lieut., Army.
Church, E. F., First Lieut., Army.
Churchill, J. B., Seaman, Navy.
Clark, W. H., First Lieut., Army.
Cooper, Guy H., Pvt., Army.
Colbert, L. O., Lieut. Comdr., Navy.
Coleman, M. M., Pvt., Army.
Conoly, Luther H., Pvt., Army.
Conover, C. N., Lieut., Navy.
Cook, Thomas, Seaman, Navy.
Cotton, H. A., Lieut. (j. g.), Navy.
Cowie, G. D., First Lieut., Army.
Cox, John W., Second Lieut., Army.
Crawford, J. H., Pvt., Army.
Cunningham, F. B., Pvt., Army.
Curtice, Sanger, Seaman, Navy.
Dailey, I. M., First Lieut., Army.
Daniels, Alonzo, Seaman, Navy.
Dann, B. G., Pvt., Army.
Deck, W. H., Sergt., Army.
Deggeller, Martin N., Pvt., Army.
Deritis, A., Seaman, Navy.
Disney, Lindsay P., Pvt., Army.
Dolan, D. J., Seaman, Navy.
Dreifus, A., Seaman, Navy.
Durgin, George H., Lieut. (j. g.), Navy
Dwyer, J. F., Pvt., Army.
Eickelberg, E. W., Capt., Army.
Ela, Arthur J., Lieut., Navy.
Ellenbogen, L. K., Pvt., Army.

Ellis, Edmund P., Capt., Army.
Ellis, E. K., Pvt., Army.
Engle, F. G., Lieut., Navy.
Farrow, J. B., Seaman, Navy.
Ferguson, A. G., Seaman, Navy.
Fleetwood, J. R., Seaman, Navy.
Floyd, Morey, Seaman, Navy.
Foxhall, Edward, Seaman, Navy.
Freeman, Bert C., First Lieut., Army.
Galos, Benjamin, Ensign, Navy.
Gannon, H. F., Seaman, Navy.
Gatje, E. A., Pvt., Army.
Giacomini, Alfred L., Lieut., Navy.
Gidayawan, Aurilio, Seaman, Navy.
Gilden, G., Seaman, Navy.
Godsey, J. E., Pvt., Army.
Graham, Lyman D., Lieut., Navy.
Gramm, S. G., Pvt., Army.
Green, Charles K., Lieut. (j. g.), Navy.
Greenfield, Murray G., Sergt., Army.
Groshong, F. R., Seaman, Navy.
Grummann, Herbert R., First Lieut., Army.
Hall, F., Seaman, Navy.
Hallberg, Arthur S., Lieut., Army.
Hardy, Francis H., Lieut. Commander, Navy.
Harris, J. J., Seaman, Navy.
Harrison, Henry, Seaman, Navy.
Harsh, Dwight B., Pvt., Army.
Hart, Oscar, Seaman, Navy.
Hartley, George R., First Lieut., Army.
Haydon, Rufus, Pvt., Army.
Hayes, Chester, Pvt., Army.
Heck, N. H., Lieut. Commander, Navy.
Hicks, Russell J., Pvt., Army.
Hinkley, Wilmer O., Ensign, Navy.
Hodgson, C. V., Maj., Army.
Hole, Robert J., First Lieut., Army.
Hollander, F., Seaman, Navy.
Horne, R. D., First Lieut., Army.
Howes, Leonard G., Seaman, Navy.
Hughes, James, Seaman, Navy.
Hunter, C. M., Pvt., Army.
Huse, Emery, Pvt., Army.
Hutchinson, R. F., Pvt., Army.
Jacobsen, William F., Pvt., Army.
Joachims, Arthur, Lieut. Commander, Navy.
Joekel, F. E., First Lieut., Army.
Joers, Rudolph, Lieut., Navy.
Johanson, W., Seaman, Navy.
Johnson, Berkeley, Pvt., Army.
Johnson, B. L., Seaman, Navy.
Johnston, W. R., Pvt., Army.
Jones, E. Lester, Col., Army.
Kates, P., Seaman, Navy.
Kelsh, Harry T., First Lieut., Army.
Kerns, J. L., Seaman, Navy.
Keyse, William S. P., Lieut. Commander, Navy.
Kight, J. F., Seaman, Navy.
Kilgore, Addison, Seaman, Navy.
King, J. L., Seaman, Navy.
Kirby, Harold L., Pvt., Army.
Kremkau, Omer G., Pvt., Army.
Lambert, Frank, Pvt., Army.
Lambert, Walter D., First Lieut., Army.
Landing, T. R., Seaman, Navy.
Lane, Paul V., Lieut., Navy.
Lea, Wilbur R., Pvt., Army.
Lee, Alfred M., Seaman, Navy.
Lee, Harvey, Pvt., Army.
Levy, M. E., Lieut. (j. g.), Navy.
Lewis, W. P., Seaman, Navy.
Littlefield, R. C., Pvt., Army.
Loken, A., Seaman, Navy.
Laubat, Frank J. C., Pvt., Army.
Luce, G., Lieut., Navy.
Luce, Robert F., Lieut. Commander, Navy.
Lukens, Richard R., Lieut. Commander, Navy.
McComb, H. E., Lieut. (j. g.), Navy.
McFarland, W. M., Second Lieut., Army.
McGuire, J. W., Capt., Army.
MacKenzie, W. J., Second Lieut., Army.
McMillin, Clarence E., Seaman, Navy.
McMinn, Robert, Pvt., Army.
Maher, Thomas J., Lieut., Navy.
Manget, H. F., Pvt., Army.
Marchand, G. E., Lieut., Navy.
Marsh, J. E., Lieut., Navy.
Martin, R. B., Pvt., Army.
Mattison, George C., Lieut. (j. g.), Navy.
Midgett, L. L., Seaman, Navy.
Midgett, Orlando, Pvt., Army.
Miller, Raymond V., Lieut. (j. g.), Navy.
Mills, Gilbert E., Pvt., Army.
Montrolo, Arcadio, Seaman, Navy.
Moore, C. E., Pvt., Army.
Morris, T. J., jr., Seaman, Navy.
Mourhess, C. A.. Lieut., Army.
Mower, L. M., Second Lieut., Army.
Murray, Charles R., Pvt., Army.
Myers, Benjamin, Pvt., Army.
Nelson, K. E., Lieut., Navy.
Noblencn, Louis, Pvt., Army.
Nyland, Fritz C., Ensign, Navy.
O'Conner, T., Seaman, Navy.
Oles, Floyd, Pvt., Army.
Oscarson, P. K., Seaman, Navy.
Overton, R. C., Ensign, Navy.
Paddison, O. H., Lieut. (j. g.), Navy.
Pagenhart, Edwin H., Capt., Army.
Parker, Ernest, Pvt., Army.
Parker, H. F., Seaman, Navy.
Parker, W. E., Lieut. Commander, Navy.
Pascoal, Doreteo, Seaman, Navy.
Patton, R. S., Lieut. Commander, Navy.
Peacock, F. L., Lieut., Navy.
Pease, H. W., Second Lieut., Army.
Perrin, P. A., First Lieut., Army.
Peters, John H., Lieut. Commander, Navy.
Petterson, J., Seaman, Navy.

Pierson, C. C., Seaman, Navy.
Pigford, D. V., Pvt., Army.
Pigford, Robert, Pvt., Army.
Pinner, R., Seaman, Navy.
Pittmann, C. W., Pvt., Army.
Powell, J. D., Capt., Army.
Powell, W., Seaman, Navy.
Prenzlau, T., Seaman, Navy.
Quillian, C. G., Lieut. Commander, Navy.
Ramos, Andres, Seaman, Navy.
Ramos, Apolonio, Seaman, Navy.
Rappleye, Howard S., Lieut., Army.
Raynor, Leroy P., Lieut., Navy.
Ready, C. T., Seaman, Navy.
Reese, E. E., First Lieut., Army.
Robinson, C. B., Seaman, Navy.
Romberg, B. A., Seaman, Navy.
Rozier, B. B., Pvt., Army.
Rude, Gilbert T., Lieut. Commander, Navy.
Ruest, J., Seaman, Navy.
Ruffner, Walter S., Pvt., Army.
Ruiz, Frank S., Pvt., Army.
Rycraw, George H., Pvt., Army.
Sandoe, Nichol M., Seaman, Navy.
Schoppe, R. L., Lieut., Navy.
Seran, H. A., Lieut. Commander, Navy.
Severns, E. V., Pvt., Army.
Sewell, Leo A., Pvt., Army.
Shalowitz, A. L., Second Lieut., Army.
Shell, W. R., Pvt., Army.
Shoemaker, H. C., Seaman, Navy.
Sigales, G., Seaman, Navy.
Singleton, Cleve, Seaman, Navy.
Skare, Charles E., Pvt., Army.
Skau, Rolf, Pvt., Army.
Smith, Dean O., Pvt., Army.
Smith, E. L., Seaman, Navy.
Smith, J., Pvt., Army.
Smith, Sherman, Pvt., Army.
Smith, S. P., Seaman, Navy.
Smith, W. M., jr., Seaman, Navy.
Spills, John H., Pvt., Army.
Springle, D. D., Seaman, Navy.
Spry, H. S., Seaman, Navy.
Staeblain, T., Seaman, Navy.
States, Earl C., Pvt., Army.
Stewart, George, Pvt., Army.
Strough, R. P., Lieut. Commander. Navy.
Taylor, Dan W., Seaman, Navy.
Thompson, George, Pvt., Army.
Thompson, M., Seaman, Navy.
Thurtell, C. S., Pvt., Army.
Tolson, J. Q., Seaman, Navy.
Torres, Anastacio, Seaman, Navy.
Toulson, J. M., Seaman, Navy.
Trueblood, Paul M., Lieut., Navy.
Ulrich, L. C., Pvt., Army.
Vandewynckele, Paul, Pvt., Army.
Vess, L. J., Seaman, Navy.
Waff, F. E., Seaman, Navy.
Walker, Eustace S., Lieut., Navy.
Watkins, John T., Lieut. Commander Navy.
Weidlich, W., Lieut. (j. g.), Navy.
Welfore, Leon, Seaman, Navy.
Wells, John M., Seaman, Navy.
Wheeler, Raymond A., First Lieut., Army.
Whidbee, N., Seaman, Navy.
White, Albert, Seaman, Navy.
Whitney, Paul C., Lieut. Commander. Navy.
Wilder, Leo C., Lieut., Navy.
Wilkey, J. M., Seaman, Navy.
Williams, Preston S., Pvt., Army.
Witherbee, Max O., Second Lieut., Army.
Witherspoon, Andrew C., First Lieut., Army.
Woolbert, A., Seaman, Navy.
Wrenn, C. A., Pvt., Army.
Young, C. H., Pvt., Army.
Youngblood, Adam, Pvt., Army.
Zeitlin, R. M., Seaman, Navy.

This Bureau also contributed five of its survey vessels to the fleets operated by the Navy. One of our vessels, the *Surveyor*, was employed on convoy duty to and from Mediterranean ports. While on one of these trips, a convoy was attacked by two German submarines, one of which was the famous *U-39* which sunk the *Lusitania*. The *U-39* fired a torpedo at the fleet which grazed the bow of the *Surveyor* and was visible from the deck of that vessel. The wake of the submarine was picked up by the *Surveyor* and she was able to get in a position for favorable discharge of the depth charge. As the *Surveyor* was unable to leave the convoy, she was unable to return and finish the submarine, but did succeed in disabling her to the extent that the submarine was compelled to enter Cartagena, Spain, and intern there. Another of our vessels, the *Isis*, was on duty at New York as flagship of commandant, squadron 2, cruiser force, from November 16, 1917, to October 14, 1918, and was on duty at Yorktown and Hampton Roads as flagship of division 4, battleship force 1, from October 15, 1918, to April 1, 1919. A third one of our vessels, the *Bache*, was assigned to squadron 5 of fifth naval district, and performed general salvage work, outside patrol, and guard-ship duties off Virginia Capes. Her primary duty was identification and passing of all inbound and outbound vessels. She was the means of communication between naval authorities and these vessels. She handled mail and gave medical assistance to passing vessels, and performed important salvage operations. Two other vessels of the Bureau were in the naval service on the Pacific coast. They were the *Explorer* and the *Patterson* (renamed the *Forward*). These vessels were assigned to patrol duty in Alaskan waters.

Besides this direct assistance to the military branches of the Government by the contribution of men and vessels, this Bureau rendered valuable aid to both these branches through the efforts of its field and office force. In the field, this assistance consisted in furnishing certain control for maps in critical areas selected by the chiefs of military mapping of the Corps of Engineers of the Army. These areas were in Texas, Georgia, Florida, South Carolina, North Carolina, and Virginia. The work was chiefly triangulation, traverse, and leveling. Special hydrographic examinations were made by means of the wire drag at points designated by the Navy Department. Among such were the wire-drag surveys in Long Island Sound and in York River (Chesapeake Bay). Quite an extensive wire-drag examination was made of the waters in the vicinity of Eastport, Me. Initial surveys included such work as the location of points for naval fire-control experiments, the reestablishment of the speed-trial course at Lewes, Del., for torpedo-boat destroyers, the location of the Port Jefferson trial course in Long Island Sound, and the Block Island (Rhode Island) trial course.

Some divisions of the office were engaged almost exclusively on work that would be of use to the Army and Navy during the war. This work consisted of the computation of precise traverse, and of several grades of triangulation and of precise leveling executed within areas selected by the division of military mapping of the Corps of Engineers of the Army. Magnetic data were supplied to various Army and Navy organizations, and to persons engaged on investigation of the submarine problem. Another important accomplishment in connection with the war was the furnishing of our nautical publications, consisting of charts, coast pilots, tide tables, for the use of our naval vessels, our Merchant Marine, and the vessels under the control of the Army, and the Railroad Administration.

This service has 103 years of active history which show that it has never failed in loyalty, no matter what the call. Its members have always given the benefit of their trained thought and well-informed judgment whenever and wherever they were needed and however they could best be used.

In the great conflict just ended these traditions have been upheld.

Admiration is due the spirit that has animated each and every member of the United States Coast and Geodetic Survey. To a man there was an instant and eager response to the country's call for help. At all times, a service which is laboring for the safety of mankind, it stood ready to undertake new work. The kind of work needed was varied—all could not go into battle. The men in the field would have been useless without the executive work behind them at home, and all honor is due them, who, showing a steady, uncompromising moral courage, unmoved by clamor and undisturbed by outer excitement, have kept steadily at their posts, carrying on most successfully the important and necessary work here.

Those who were sent to the field were simply performing their duty in another way, and established an enviable and remarkable record, showing again their unusual adaptability and training.

The Bureau was about equally represented in both Army and Navy and performed signal valuable service in each.

# Part IV.—STATEMENT FOR THE PAST YEAR OF ACCOMPLISHED FIELD AND OFFICE WORK, ACCOMPANIED BY ILLUSTRATIONS, AS REQUIRED BY STATUTE, SHOWING THE PROGRESS MADE, ETC.

## DIVISION OF HYDROGRAPHY AND TOPOGRAPHY.

The division of hydrography and topography has supervision of all hydrographic and topographic surveys executed by this Bureau, which supervision includes the determination of where surveys or resurveys are required, how they shall be conducted, the preparation of instructions for surveying parties, the organization of the parties, and the inspection of the field work, and examination of the records. It is also charged with the construction, maintenance, and repairs of the vessels and other field equipment, except instruments, the records of the personnel employed on this work, the compilation of the coast pilot in the field and office, the observation of tides and currents, and compilation of tide tables.

For administrative purposes, the division is divided into four sections, known as the section of field work, section of vessels and equipment, section of coast pilot, and section of tides and currents. Each of these sections is under the direction of a hydrographic and geodetic engineer, who is responsible for the efficient and economical administration of his section under the general supervision of the chief of the division of hydrography and topography.

The division also has supervision over the five field stations located at Boston, New York, New Orleans, Seattle, and San Francisco, respectively, and over the office at Manila, P. I. The field stations are for the purpose of maintaining close relations between the Bureau and those who have occasion to use its charts, publications, and data, and to keep the Bureau informed of the needs for further work in these general localities. They are in charge of hydrographic and geodetic engineers, but undertake no surveys unless specifically directed to do so by this office. The Manila office performs all of the functions of a field station, and in addition, has direct charge of all surveys in the Philippine Islands and much of the office work incident to these surveys. This office is in charge of a hydrographic and geodetic engineer, with the title of Director of Coast Surveys.

This report gives a general statement of the work performed during the year under the direction of the division by the various field parties, the field stations, the Manila office, and finally, a resumé of the work of the four sections. Detailed statements are given in the reports of the chief of sections attached hereto, and by the chief of parties already submitted.

### MILITARY WORK.

A very large part of the topographic, hydrographic, and wire-drag work of the Bureau done during the fiscal year, was at the request of the Navy Department to meet urgent military needs. The Bureau and its field parties, including field stations, cooperated closely with the Navy and War Departments in the matter of supplying charts and other information, the execution of surveys for the establishment of camp sites, and manufacturing plants, and to bring charts up to date, and in the marking of obstructions to navigation. Frequent consultations and correspondence were carried on at Washington with the various bureaus of the War and Navy Departments relative to the work required, and in the field, the parties cooperated to the fullest extent with local military authorities.

The steamers *Bache*, *Explorer*, *Isis*, *Patterson* and *Surveyor*, turned over to the Navy during the previous fiscal year, continued operations as war vessels until the termination of hostilities, and were then returned to this Bureau under authority of Executive order of February 26, 1919.

The same Executive order returned to duty in this Bureau all those officers who had been detailed during the war for duty with the War and Navy Departments. Some of these officers went into the Navy with the vessels on which they were serving at the time of the vessel transfer, but many of them went directly to the Navy and Army from the Washington office, the field stations, and from various field parties. The return of these officers, as well as the vessels, although designated for not later than April 1, 1919, was in many cases delayed by unavoidable conditions until near the end of the fiscal year.

## NEW VESSELS AND LAUNCHES.

The Bureau has received by transfer from the Navy Department, five vessels of various sizes ranging from 100 tons to 400 tons displacement, and has the promise of two other vessels of 500 tons and 600 tons displacement, respectively, to be transferred early in the next fiscal year. The vessels received to date are the steamers *Arcturus*, *Onward*, *Ranger*, and *Wenonah*, and the motor vessel *Natoma*. The steamers *Lydonia*, and *Sialia* are to be transferred later on. All these are former yachts that were acquired by the Navy, fitted and used as patrol boats, and in the suppression of enemy submarines. On the termination of hostilities, they were no longer required by the Navy, and were, therefore, turned over to this Bureau for use as survey craft until more suitable vessels could be had.

The Navy also transferred to this Bureau eight miscellaneous motor boats, six of them of the cabin-cruiser pleasure-boat type, and two of them of the work-boat type. These launches will be used for wire-drag operations, and for chart revision, and will help to eliminate the former necessity of hiring launches.

Contracts were made during the year for the construction of four 60-foot wire-drag guide launches, and for three 30-foot wire-drag launch tenders. All of the guide launches, and one of the tenders were completed and put into service before the close of the year. A fourth tender was purchased, and equipped with a new engine.

Bids were obtained by the U. S. Shipping Board, Emergency Fleet Corporation, for the construction of two 1,000-ton surveying vessels of the *Surveyor* type. No award has been made owing to the disinclination of the Emergency Fleet Corporation to authorize the construction without further authority.

## FIELD WORK, ATLANTIC COAST.

*Field stations.*—Field stations of the Survey, each in charge of a field officer of the Bureau, were maintained at Boston, New York, and New Orleans, where there is kept a stock of charts, and also other publications of the Survey and of the Bureau of Lighthouses for consultation and for sale. The stations cooperate with the sales agents of the Bureau by furnishing them charts and other publications to meet immediate needs. The inspectors at these stations have for their principal duty the inspection of the navigable waters within their districts, for the purpose of keeping charts and other nautical publications of the Bureau corrected to date. The routine duties of the field station are handled by a clerk. The following special assignments were made to the inspectors at Boston, New York, and New Orleans during the year, in addition to the duties of the field stations:

The inspector at Boston continued the field examination of the coast between Gloucester and Boston, preparatory to undertaking the field work of making a chart revision of this locality for use on a large-scale chart of this area, which is urgently needed, especially of the important harbor of Lynn, Mass. Also, a field revision of the topography of this section was made. A field party under an inspector revised the triangulation and topography between Manchester and Boston. The inspector also cooperated with the commandant of the first naval district in the installation of apparatus for observing currents, and furnished instructions in the method of taking and recording observations.

The inspector at New York executed a supplementary triangulation at Sandy Hook, requested by the Navy Department in connection with the proving grounds for heavy ordnance; completed the computation of triangulation on the coast of New Jersey for the Army and Navy; cooperated with the Army Engineers in the determination of the position of three towers at Fort Tilden; and completed special tidal data for Brooklyn and other newspapers. Supervision was also exercised over the permanent tidal station maintained by the Bureau at Fort Hamilton, New York Harbor.

The inspector at New York cooperated with the commandant of the third naval district in the installation of apparatus for observing currents, and furnished instructions in the method of taking and recording observations. At the close of the fiscal year the inspector was engaged on a tidal current survey of New York Harbor.

The inspector of the Bureau at New Orleans cooperated in an advisory capacity with the board of advisory engineers of the Public Belt Railroad Commission appointed to report upon the physical and financial feasibility of a Mississippi River railroad crossing at, or in the vicinity of, New Orleans, together with terminal improvements collateral thereto. The inspector verified the topography in the vicinity of Pascagoula, Miss., in October, and in January, 1919, he was at Mobile, Ala., executing the necessary field work to furnish up-to-date information for charts, and installing apparatus for observing currents on Heald Bank Light Vessel. In February, he accompanied the superintendent of lighthouses on an inspection trip from Morgan City to New Orleans, proceeding by the outside route to Grand Pass Timbalier, and thence by the inside route to New Orleans.

*Vessels.*—The steamer *Bache* was returned to the Coast and Geodetic Survey on June 20, 1919, after completion of repairs by the Navy Department. No field work was in progress at the close of the fiscal year, but the necessary tall hydrographic signals were in the course of erection, and arrangements had been completed for the placing of buoys, prior to beginning offshore hydrography off the entrance of Chesapeake Bay. On authorization by the Navy Department the *Bache* was furnished with one 24-foot coast guard motor launch, in place of the motor whaleboat formerly on this vessel, and two new coast guard whaleboats, which will give her a better boat equipment than she had prior to transfer to the Navy.

The steamer *Isis* was returned to the Coast and Geodetic Survey on April 30, 1919. After receipt of the vessel by this Bureau, several tubes gave way in both boilers, and it was necessary to take the vessel to a shipyard for renewal of the tubes. No field work was in progress at the close of the fiscal year, but the necessary tall hydrographic signals have been erected, and arrangements made for the placing of buoys, for beginning the offshore hydrography off the entrance of Delaware Bay.

The steamer *Hydrographer* was employed during the first half of the year on surveys of the lower part of Chesapeake Bay, embracing the main channel of the bay, and approaches to Hampton Roads, to meet the needs of the Navy Department. On completion of repairs early in January, the *Hydrographer* left Baltimore for Key West, where she is now working in cooperation with officers at the naval station. An improved type of sounding tube was tested with marked success in the deep waters of the Florida Straits.

The schooner *Matchless* was employed on a survey of York River and approaches, continuing along the west shore of Chesapeake Bay to the vicinity of Hampton, and as far westward as Newport News. The hydrography included the area of Hampton Roads, and the inshore area between the Tail of the Horseshoe Light, and York River. This vessel also completed surveys in the vicinity of Wormley Creek, at the request of the Navy Department. After an inspection by a board appointed for the purpose, the *Matchless* was surveyed, condemned, and appraised, in accordance with authority granted on April 16, 1919, by the Secretary of Commerce. The vessel was sold on June 26, 1919.

The steamer *Onward* was received from the Navy Department on April 19, 1919, after completion of the necessary repairs, and the crew and equipment of the schooner *Matchless* were transferred to that vessel. This vessel has been employed on a continuation of the field work assigned to the schooner *Matchless*.

The steamer *Ranger* was received from the Navy on April 28, 1919. After completion of the necessary repairs she will take up offshore hydrography in the vicinity of Pensacola, Fla. A party attached to the vessel was engaged on work preparatory to the hydrographic survey of Gravesend Bay, New York Harbor. The work of building tall hydrographic signals for the surveys westward of Pensacola, Fla., was in progress at the close of the year, prior to the arrival of the steamer *Ranger* on the working ground.

*Parties.*—Wire-drag party No. 1 was employed on surveys, requested by the Navy Department, off the easterly end of Long Island Sound, and the westerly end of Block Island Sound, including Fishers Island Sound. Strong currents retarded the progress of the work, and it was generally necessary to plan the work so as to drag in the direction of the current. At the request of the Navy Department, this party completed a wire-drag survey of an area in the approach to New London Harbor.

Wire-drag party No. 2 continued the survey of the principal channel from the sea to Eastport, and Passamaquoddy Bay, and the survey of Passamaquoddy Bay to meet the needs of the Navy Department. The party maintained temporary buoys on the dangerous rocks found by the survey in the principal entrance to Eastport and Passamaquoddy Bay, until arrangements were made with the Lighthouse Service to establish permanent buoys. The Geodetic Survey of Canada cooperated with this party in signal building and triangulation.

On completion of surveys in the vicinity of Eastport, Me., the party was employed on surveys along the outer coast in the vicinity of Jonesport, Me., the work being designed primarily to meet the needs of the Navy Department.

Wire-drag party No. 5 continued the survey of Block Island Sound. The work at Key West, originally assigned to this party, was discontinued in order to meet the immediate requirements elsewhere of the War and Navy Departments. At the request of the War Department, this party executed a resurvey of Southwest Ledge.

A field party was employed on a triangulation and topographic revision survey of the coast between Manchester and Boston, in conformity with instructions issued to the inspector at Boston. This work is preliminary to the preparation of a chart on an adequate scale to cover this locality, including the harbor of Lynn. This party completed the shore line from Manchester to Magnolia, and the Chelsea River from Revere to Chelsea, and a topographic revision of the outlying islands.

A field officer investigated the subject of coast surveying and revision by means of airplane photography in conjunction with aviators of the War and Navy Departments. This officer executed a trigonometric control for an Atlantic City, N. J., photographic survey, and at the close of the year was studying the photographs taken by Army and Navy fliers with reference to this control.

A field officer established a trial course 1 nautical mile in length in the vicinity of Anacostia, D. C., to meet the needs of the Navy Department, that Department furnishing the necessary launches and material. During the latter part of the fiscal year this officer was employed on a tide and current survey in the vicinity of Point Judith, Block Island Sound.

A field party was employed during the latter part of the year on a tide and current survey along the coast between Portsmouth, N. H., and Portland, Me.

A field party was employed on a hydrographic and topographic survey of the Turtle River, Ga., to the picric acid plant at Crispen Island to meet the needs of the construction division of the Army.

After examination by the chief of the division of hydrography and topography, it was found that a suitable revision of Charleston, S. C., and vicinity could be made within the limits of funds available for this work, and, in conformity with instructions, a field officer completed, with the assistance of the superintendent of lighthouses and other local authorities at Charleston, the requested triangulation. Local interests and Government officials showed a gratifying spirit of cooperation and interest in this work.

A field party executed a systematic hydrographic and topographic survey of Key Biscayne Bay, and channels from the sea, to meet the need of navigators and commercial interests at Miami, Fla.

An officer inspected the tide and current survey parties working off the coast of New England, and in Block Island Sound and vicinity, and tide station at Portland, Me. He also consulted with the inspector at New York relative to the tide and current survey party being organized for work in New York Harbor.

A field party has been employed on a triangulation and topographic survey of the Virgin Islands, requested by the Secretary of the Navy on August 28, 1917. This party is cooperating closely with the governor and other naval officials of the Islands, and good progress is being made in this work. The work on St. Thomas and St. John is completed, and the party is now employed on St. Croix. The governor of the Islands has requested that a wire-drag survey be made in that vicinity as early as practicable.

## FIELD WORK, PACIFIC COAST.

*Field stations.*—Field stations of the Survey, each in charge of a field officer of the Bureau, were maintained at Seattle and San Francisco during the fiscal year, where there is a stock of charts and other publications of the Survey, and of the Bureau of Lighthouses for consultation and for sale. The stations cooperated with the sales agents of the Bureau by furnishing them charts and other publications to meet immediate needs.

The inspector has for his principal duty an inspection of the navigable waters within his district, for the purpose of keeping charts and other nautical publications of the Bureau corrected to date. The routine duties of the field station are handled by a clerk. The inspectors at the two Pacific coast field stations had charge of the arrangements for installing current-measuring apparatus on light vessels within their districts. Tidal and current observations have been in progress at the stations maintained by the field stations.

The Seattle field station has served as the headquarters for the field parties operating in Washington and Alaska, and has rendered valuable assistance to the field parties. The inspector had charge of the preparation of plans and specifications of the vessel to replace the steamer *Taku*, and issued specifications and plans, and opened bids for the construction of the vessel. A 1-mile speed-trial course was laid out by him on Lake Washington for immediate use of vessels under construction at that point. The inspector cooperated with the Navy Department at Puget Sound Naval Station, relative to the return of the steamers *Explorer* and *Forward* (*Patterson*), and three of the launches received from the Atlantic coast.

The inspector at San Francisco, assisted by local coast guard stations, was employed on a survey of Presidio Shoal on the northerly waterfront of San Francisco, made necessary by reports of very much shoaler water than charted.

*Vessels.*—The steamer *Sialia* is being repaired by the Navy prior to transfer to the Coast and Geodetic Survey.

The steamer *Wenonah* was received from the Navy on April 12, 1919, after completion of the necessary repairs, and proceeded to the Pacific coast via the Panama Canal. This party will, on arrival, take up offshore hydrography in the vicinity of Cape Mendocino, and the survey of Humboldt Bay when weather conditions prevent outside work.

The motor vessel *Natoma* was received from the Navy on April 9, 1919, after completion of the necessary repairs, and proceeded to the Pacific coast, via the Panama Canal. She will be used on the resurvey of San Francisco Bay.

The steamer *Arcturus* was received from the Navy on May 5, 1919, after completion of such repairs as the Navy was willing to make. At the close of the fiscal year, she was undergoing repairs that were necessary, due to the fact that repairs previously made were incomplete.

Vessels proceeding to the Pacific coast of the United States and to Alaska, with the exception of the *Natoma*, were directed to take soundings, and make oceanographic observations while en route, and the track to be followed by each vessel in the Atlantic Ocean, Caribbean Sea and Pacific Ocean was laid out in advance so that each would develop an unexplored track.

The steamer *Explorer* was returned to the Coast and Geodetic Survey on May 1, and the *Forward* (*Patterson*) was returned on May 24. These vessels have been condemned, and will be sold.

*Parties.*—A field party was employed on a systematic hydrographic and topographic revision survey of the Tacoma waterfront, to show the extensive improvements which have been made at that point.

A field officer has been employed in arranging for repairs to the launches received from the Navy, and shipped to the Pacific coast on Naval colliers to fit them for wire-drag and revision work on the Pacific coast. He is, also, preparing to begin wire-drag work in Lake Washington and Lake Union after July 1.

A field officer was employed on a revision survey of Los Angeles Harbor to bring our charts up to date.

A field party was employed on a hydrographic and topographic revision survey of Morro Bay, requested by local interests. After completion of the Morro Bay work, the party proceeded to Eureka, Calif., and took up the work of recovering and re-marking triangulation stations in that vicinity, and building the necessary signals for the offshore work which will be done by the vessels of the Bureau on their arrival from the Atlantic coast.

A field party completed a wire-drag survey of Lake Tahoe to meet the needs of the United States Reclamation Service. This survey was limited to the shores where numerous bowlders and uncharted rocks were found.

## FIELD WORK, ALASKA.

*Vessels.*—A field party with the launch *Cosmos* completed a survey of the north end of Wrangell Strait in order to locate certain bowlders that have been reported in this important fairway. The improvised harbor sweep used on the *Cosmos* was carried away several times owing to the very strong currents, but lead-line development was checked by the sweep at critical points, enabling the party to complete the work in a satisfactory manner. This party also made a survey of Keete Inlet, Cordova Bay, Alaska.

The steamer *Surveyor* was returned by the Navy on April 1, 1919, after completion of the repairs necessary to place the vessel in condition for survey work, and proceeded to Alaska, via the Panama Canal. At the close of the fiscal year the vessel was at Seattle, repairing and outfitting for work on the south coast of the Alaska Peninsula.

*Parties.*—A field party completed a survey of Port Chatham, Kenai Peninsula, to enable the Chrome Mining Co. to ship their product. From local reports, and information received from the Bureau of Mines, it appeared that the chrome-iron deposits in this locality are important, and that their production was a necessity for certain war products. Surveys were also completed by this party in Seldovia to locate the uncharted rock which had been reported by local interests in the vicinity of the wharf. A survey was made of Halibut Cove, Kachimak Bay, to enable fishing interests to ship their product, and Knik Arm in the approaches to the railroad terminal at Anchorage, Alaska, was surveyed. This work was done at the urgent request of the Alaskan Engineering Commission.

An automatic tide gauge was established at Anchorage, to be operated by the Alaskan Engineering Commission, and tides were observed at that point.

## FIELD WORK, PHILIPPINE ISLANDS.

The director of coast surveys, acting under the authority of the superintendent. makes plans for the work of the Survey in the Philippine Islands, issues detailed instructions to the field parties, and has charge of the field station at Manila.

The expenses of the work are met by the Coast and Geodetic Survey and Philippine Government, which also furnished three vessels for surveying purposes during the fiscal year. The steamer *Pathfinder* is furnished by the Coast and Geodetic Survey.

During the fiscal year, the *Pathfinder*, *Romblon*, and *Fathomer* were employed on surveys in the Philippine Islands. Work was done on the east coast of Palawan, and in the vicinity of Cuyo Islands in the northerly part of the Sulu Sea. While these vessels were undergoing repairs, launch parties were engaged on a survey of Laguna de Bay.

The steamer *Marinduque* is temporarily in the service of the insular government, but will be returned to the jurisdiction of the Coast and Geodetic Survey about July 1. The officers for this vessel left San Francisco for Manila on May 25, 1919.

The epidemic of influenza which occurred in the fall of 1918 seriously hampered the work of the Coast and Geodetic Survey. A number of officers, and many of the crews of the vessels were stricken with the disease, seven deaths having occurred on the steamer *Pathfinder* alone.

## MISCELLANEOUS FIELD WORK.

The question of aerial surveying is under consideration, and it is believed useful service may be obtained in such localities as follows:

Florida reefs (for the purpose of locating coral heads).

Ten Thousand Islands, west coast of Florida between Cape Sable and Big Marco Pass. (These so-called Ten Thousand Islands are embraced within an enormous swamp where little or no solid land may be expected.)

Delta of the Mississippi. (Aerial photographs could be used to fill in the details of the interior of the delta.)

Suggestion has been made that the topographer should work with an airplane, and photograph the country as needed to put in the changes. Triangulation could then be done as necessary to put in the landmarks for charts and other control points that might be needed to make full use of the photographs. Photographs could be taken of bodies of shallow water in order to determine the direction of the slues or channels leading between the extending shoals, and thus verify and, if necessary, correct the charts. The above suggestions cover points where airplane hydrography can unquestionably assist in bringing our charts up to date.

At the invitation of the British Admiralty, the chief of the division of hydrography and topography, and the chief of the section of field records, attended an international hydrographic conference at London, England, during the latter part of June. In a letter from the charge d'affairs ad interim dated June 4, 1919, the object of the conference is stated as follows:

> To consider the advisability of all maritime nations adopting similar methods in the preparation, construction, and production of their charts, and all hydrographic publications; of rendering the results in the most convenient form to enable them to be readily used; of instituting a prompt system of mutual exchange of hydrographic information between all countries; and of providing for consultations and discussions to be carried out on hydrographic subjects generally by the hydrographic experts of the world.

## SECTION OF FIELD WORK.

The principal duties of this section are the supervision of topographic and hydrographic surveys, and coordination and standardization of the work of the various field parties, with a view to having a complete and continuous survey of the coast. All data pertaining to the locality in which work is to be done are assembled, compared, and studied, and instructions prepared accordingly. Close touch is kept with the field work through reports and sketches from the field party.

Data were collected, and itemized memoranda prepared for 23 sets of instructions for field work. This embraced a careful study of existing surveys. Original field sheets covering areas where changes frequently occur, and where preliminary surveys only have been made, were reviewed in order to formulate plans for performing the necessary field work to bring the charts up to date. Completed field sheets were reviewed, as time permitted, preparatory to recommending them for the approval of the superintendent.

Owing to the unusual conditions that have prevailed, and the requirements of war work, and surveys that have been made a part of the National defense, the duties of the chief section have embraced many matters not heretofore performed. The chief of the section of vessels and equipment was transferred to the Navy Department for the period of the war, and during his absence the chief of this section acted as chief of the section of vessels and equipment. The principal items of work were in connection with the construction of the 60-foot wire-drag launches, and 30-foot tenders, proposals for the steamer to replace the *Taku*, and revision of specifications for the new 1,000-ton steel surveying vessel.

### SECTION OF VESSELS AND EQUIPMENT.

This section is charged with the preparation of plans and specifications for new vessels and equipment, the care, maintenance and repair of existing vessels, and the records of seamen personnel. This latter includes the examination of nearly all reports and returns, except pay accounts and reports of survey work, required to be submitted by parties afloat. The section also examines and passes for approval of the chief of division and the superintendent the estimates of field expenses submitted by all parties afloat and ashore, and all contracts for lease and charter.

A considerable part of the work of the section is inspection of vessels and equipment, and an effort is made to inspect thoroughly every vessel in the Survey, except those in the Philippine Islands, at least once annually, and the vessels on this coast at least twice annually. Supervision of the Philippine vessels is maintained by means of reports from the director of coast surveys.

Until April 1, this section was under the direction of the chief of field work during the absence on Naval duty of the chief of section.

### COAST-PILOT SECTION.

During November, 1918, the manuscript of the Philippine Coast Pilot, Part 1, was read and sent to the printers. To the end of the fiscal year, the work of the section included the reading of the page proofs of the Philippine Coast Pilot.

Reprints were obtained during the year of Atlantic Coast Pilots, Sections D and E. Supplements for three volumes, and correction sheets for Sections C, D, E, California, Oregon, and Washington, and Alaska, Part 1, were issued.

The record of the issue of coast pilots in recent years is interesting as indicating the usefulness of these publications. As these volumes are sold at a price sufficient to defray the cost of printing (50 cents), it is obvious that the number sold furnishes an accurate measure of the public demand. The following is the record of the issue for the fiscal years from 1912 to date:

| | | | |
|---|---|---|---|
| 1912 | 3, 792 | 1916 | 5, 602 |
| 1913 | 3, 797 | 1917 | 7, 952 |
| 1914 | 4, 148 | 1918 | 12, 913 |
| 1915 | 4, 016 | 1919 | 13, 915 |

## SECTION OF TIDES AND CURRENTS.

Tidal observations were made throughout the year at seven permanent tidal stations along the Atlantic coast, two on the Gulf of Mexico, and three on the Pacific coast. In addition to these, observations were made in connection with hydrographic surveys in the United States, Alaska, and the Philippines. Tides were observed at 58 stations during the year, the total combined length of observations being 41 years, 6 months, 16 days.

During the year all permanent tidal stations have been inspected at least once, the inspection in all cases including the connection of the tide staff of the station with the permanent bench marks by spirit levels.

The work of making comprehensive tide and current surveys of our coasts, which was begun in the summer of 1916, was continued during the fiscal year 1919, and parties were employed on the coast between Portsmouth, N. H., and Portland, Me., and off the entrance to Narrangansett Bay.

The purpose of the tidal party is to obtain tidal information at important points along the coast, and the establishment of permanent tidal bench marks at all principal points along the coast, which will serve the public in all cases where a knowledge of tidal planes is required to furnish hydrographic parties with standard data, and afford starting and checking points for lines of precise levels.

The tidal survey is carried on by means of two automatic tide gauges, and several subsidiary staffs; current measurements are made by means of current meters, the velocity being obtained at various depths at each station, and, also, by means of a vertical pole float.

The purpose of the current survey is to obtain definite information concerning currents in navigable channels, entrances to bays, rivers, passages, and at points along the coast, for the benefit of navigators.

Current observations were made at 57 stations (other than light vessels), the total combined length of observations being 5 months 18 days.

The manuscript for the tide tables for 1920 was prepared and submitted for printing in three separate parts, namely, the Atlantic Coast Tide Tables, which are already issued; the Pacific Coast Tide Tables, the proof of which has been read; and that part of the General Tide Tables which is not included in either of the two reprints, proof of which has not yet been received. These tables are similar to those for the past two or three years.

The following table of issues shows the increased demand for these tide tables in recent years:

| Fiscal year. | General Tide Tables. | Atlantic Coast Tide Tables. | Pacific Coast Tide Tables. | Total. |
|---|---|---|---|---|
| 1915 | 1,665 | 1,994 | 10,481 | 14,140 |
| 1916 | 1,166 | 2,367 | 10,034 | 13,567 |
| 1917 | 1,548 | 3,526 | 12,704 | 17,778 |
| 1918 | 2,818 | 3,496 | 13,635 | 19,949 |
| 1919 | 4,176 | 4,043 | 14,644 | 22,863 |

## DIVISION OF GEODESY.

### FIELD WORK.

The geodetic work of the Coast and Geodetic Survey, almost from the day that the United States entered the war until the armistice was signed, may well be called war work. All the resources of the division of geodesy were placed at the disposal of the division of military mapping of the Corps of Engineers of the Army immediately after the United States entered the war.

The assistance of the division of geodesy was accepted by the engineers, and plans were made to furnish certain control for maps in critical areas selected by the chief of the division of military mapping. These areas were in Texas, Georgia, Florida, South Carolina, North Carolina, and Virginia.

Shortly after November 11, 1918, the division of military mapping of the Office of the Chief of Engineers lessened its support to the division of geodesy, and by the end of the fiscal year 1919 the assistance from the Army consisted of only a small fund from which to pay several computers making special computations of value to the division of military mapping.

### NEED FOR GEODETIC CONTROL.

It is difficult to overestimate the necessity of having a proper amount of horizontal and vertical control in this country for the use of map makers and other engineers. There is not the demand for our geodetic control that there should be, and this is almost entirely due to the fact that the work of the Survey has not, in years past, been brought to the attention of those who could use the results. It has been the policy of the superintendent, for the last four years, to get the work of the Survey before the public in order that the surveyors, engineers, and others might know what is being accomplished by the Bureau. This plan will be continued, and, in addition, literature will be distributed to the public which will show how the results of the Survey's work might be best utilized.

This relates particularly to the matter of the geographic positions of triangulation stations. These are of great value to the private surveyor and engineer, and it is planned to have a pamphlet prepared which will show them to what extent they may utilize the latitudes, longitudes, and azimuths of the triangulation and traverse work. It is noteworthy that the engineering colleges are emphasizing the need of control for surveys, and this will have a marked effect in increasing the demands on the Bureau for geodetic work.

### NEED FOR MAPS.

The Army has been using maps as never before in its work, both in this country and abroad, and the Coast and Geodetic Survey can look forward to a greater utilization of its products as a result of the numbers of men who were in the Army going back to civil life, and demanding good maps.

Aside from the value of these results in mapping for military purposes, there are many other needs for accurate control, and accurate maps. The principal use of these is probable for the Federal, State, city, and highway engineers. Hundreds of millions of dollars will be spent each year in the United States in building new roads, and in maintaining and improving old ones. It is reasonably certain that this road work could be done at a considerable saving, if the country through which the road work is carried on were properly mapped. The total coast of mapping the country topographically will be not more than about $100,000,000, and this is the amount which will be spent on roads every three months for, probably, 10 years. It would certainly be good policy to have the maps precede the building of roads, rather than to have them follow such operations.

The railroad engineers are, also, particularly interested in good maps, and it is reasonably certain that, with the development of our railroads in the future, to meet the needs of industry and commerce, good topographic maps would be of great value in enabling the work to be accomplished in an efficient manner.

### AIRPLANE SURVEYING.

There has been much talk, in recent months, in regard to surveying the country from airplanes. This is a subject in which the Coast and Geodetic Survey is much interested, because it seems probable that the airplane can be used to a great extent in revising the topography along the shores of the country, and in some parts of the interior, and also in making original surveys. The Coast and Geodetic Survey is not directly interested in airplane surveying of the interior of the country, but the Survey will certainly be expected to have control extended over the interior of the country, that airplane maps can be properly made, and located at many places.

### EXTENSION OF GEODETIC CONTROL.

It has been the plan of the Coast and Geodetic Survey for some years to extend its geodetic work so as to have control available for all Government, State, city, and private engineers and surveyors. There are many cities to-day whose maps will be placed on the wrong datum, both for elevation and position, as a result of lack of primary triangulation and precise leveling in the interior of the country. Every city of any size, and every State of the Union should be furnished by the Federal Government with the fundamental control on which can be based the surveys and maps of detailed character in any particular locality.

There can be no question that triangulation and precise leveling bench marks should be placed within 50 miles of each place in the United States. With the Federal control carried to this extent, it would be a very simple matter in the future to have detailed control placed in many areas just ahead of the surveyors and engineers who are to make the surveys and maps. This main control should be extended as rapidly as equipment and personnel of the Survey will permit, and within say five or six years should be practically completed as far as the main part of the work is concerned. It is, of course, difficult to give exact figures as to how much leveling and triangulation will be needed to finish the minimum that is essential, because plans must be changed from time to time to meet the needs of the topographic engineers; but it is reasonably certain that the primary triangulation and precise leveling which should be done within the next five years will cost about $1,000,000. With this distance of 50 miles as a criterion, it can be seen that lines of precise leveling, and arcs of primary triangulation should be approximately 100 miles apart. When it is considered that this distance is equal to that between Philadelphia and Baltimore, or Philadelphia and New York, it is realized that this is not an excessive amount of control. This estimate of fundamental control is made with a view to covering all of the country with a fair distribution of the control, and later to filling in the intermediate areas as the demands of surveyors and engineers arise.

Nothing is more conducive to proper commercial and industrial development of the country than good maps, and money spent in making them should be considered by the Nation as an investment rather than as a running expense.

This country adopted a broad plan, based on sound scientific and engineering principles, in the manner of controlling its maps. The only thing lacking is support in the way of money, and personnel to put the plan into operation.

## ADOPTION OF STANDARD GEODETIC CONTROL.

The plan is to have all public surveys and maps based on some one initial point. The decision to have the single system of coordinates for the United States was adopted by the Survey about 20 years ago, and it is looked upon as a matter to be imitated by the geodetic surveys and map makers of other countries. The system seems to have worked out so well that the same initial point, used in the United States for its surveys and maps, has been adopted by the Governments of Mexico and of Canada. We shall, therefore, see the whole North American Continent placed on a single datum. This is far ahead of the condition of affairs in any other part of the world. But while the general plan adopted has been of such splendid character, there are few countries in the world that claim to be highly developed, that have less control per square mile than the United States. In this matter, the United States is really far behind all of the European countries, except, possibly, Russia and the Balkan States. Japan, for instance, is entirely covered by triangulation of a very high standard of accuracy, and the leveling is very much more extensive in proportion to the area than in the United States.

With a good plan adopted as far as control is concerned, it is most earnestly hoped that Congress will come to the relief of the Survey, and make it possible to have the minimum amount of control that seems justified, done within the next few years.

It has been found that other organizations of the Government have needed control much ahead of the ability of the Coast and Geodetic Survey to supply it. It is not considered a good plan to allow this control work to drag. It would really be better if all survey funds used in the interior of the country were concentrated for at least a year on geodetic work, in order that control might be furnished. This money would bear good results in the way of making it possible to have surveys and maps made in a more efficient manner than is now possible.

### CONTROL ALONG THE COASTS.

The Corps of Engineers, United States Army, has, as one of its functions, the preparation of special military maps for the defense of the country and for other purposes. Most of the maps made for that organization will be close to the shores of the country. The control that will be used on those maps will be largely the tertiary triangulation along the coast done by the United States Coast and Geodetic Survey. That triangulation is, in some cases, in bad condition due to the loss of station marks from the erosion of the shores, and the works of man. It is therefore desirable that parties be sent along all of the coasts of the United States to make an inspection of the triangulation data. It is believed that at least once in 10 years the triangulation should be visited and supplemented. During such an inspection the position of any permanent object that can be used in surveying work by the navigator should be determined.

### GRAVITY WORK.

During the past two fiscal years no gravity work was done by the Coast and Geodetic Survey. The pendulums are considered to-day to be of some importance in connection with the possible location of oil-bearing rocks. In cooperation with the United States Geological Survey, it was planned, just before the war, to make certain gravity campaigns in Texas, Oklahoma, and parts of Kansas, with a view to testing whether or not the pendulum could be used in detecting oil-bearing rocks. It is hoped that this investigation will be resumed in the very near future, and for this purpose two sets of nickel-steel or invar pendulums are now being made in the instrument section of this office. With these pendulums it will be possible to observe the intensity of the gravity at any place. At present it is necessary, on account of the high coefficient of expansion of the old pendulums, to locate the gravity station in a room of constant temperature. This is usually the basement of some public or private building. On account of the necessity of having to swing the pendulum in a constant-temperature room it has been found that the points at which gravity can be observed, using the old pendulums, are very limited in number. It is intended to resume the gravity observations soon after the beginning of the fiscal year 1920.

### WAR RECORD.

The war record of the division of geodesy is a most excellent one. Those of its members who did not actually enter the military service of the Government were engaged continuously on work called for by the Army and Navy.

At the end of the war all except two of the permanent employees of the Coast and Geodetic Survey, engaged either in the field or the office work of the division of geodesy, returned to the Survey.

Men of the type engaged in the field force of this Survey, and the computing and drafting forces of the office, form a suitable body of men from whom the Army and Navy can draw officers for technical work in time of war. It is, therefore, expedient that these forces be kept up to a high standard of efficiency, both as to the number and the quality of the men, in order that they may be of the greatest value when called to military service.

## FIELD WORK ACCOMPLISHED.

Below is given a list of the pieces of work which were done during the fiscal year 1919.

At the beginning of the fiscal year 1919, a precise traverse party was working in South Carolina, on a line which extends from Savannah, Ga., to Norfolk, Va.

A line of precise traverse was executed southward in North Carolina, to meet the above work in the vicinity of Sanford, N. C.

When the Savannah-Norfolk line was completed, at Sanford, an arc of primary triangulation was begun in northeastern North Carolina, to extend from the oblique arc to Sanford. A line of precise traverse was extended from Wilmington, N. C., to a junction with the triangulation near Sanford.

Owing to the fact that there are some inconsistencies in the precise traverse in Georgia, South Carolina, and North Carolina, which was done during the war in many cases by unskilled observers, it was found necessary to make an inspection of some of these lines. This work was done between July 1, 1918, and June 30, 1919.

After the completion of the work in the Southeastern States, requested by the division of military mapping, Office of the Chief of Engineers, work was begun in Texas on an arc of primary triangulation which extends eastward from Waco, Tex., to a junction with the Mississippi River. This work was also requested by the division of military mapping.

A reconnoissance was made from the vicinity of Waco, Tex., eastward to the vicinity of Mansfield, La., and at the end of the fiscal year 1919, the reconnoissance and the erection of the towers necessary to elevate the theodolite during the observations had been completed.

A party began observations for primary triangulation in the vicinity of Waco, Tex., and at the end of the fiscal year the work had been completed nearly to the vicinity of Mansfield, La.

A line of precise leveling was begun in the spring of 1919, in the vicinity of Hillsboro, Tex., which follows in a general direction the arc of primary triangulation that is being run eastward from Waco.

A precise leveling party was engaged on a line of levels along the Rio Grande from the vicinity of Harlingen westward to Eagle Pass, Tex. That leveling was done along the country roads close to the river, and the work was difficult on account of poor roads, and the crossing of numerous streams, swollen by excessive rainfall. The party was transported by two motor trucks belonging to the Survey.

Just before undertaking the leveling along the Rio Grande, a line of levels extending from Corpus Christi to New Orleans was completed.

In the spring of 1919, the chief engineer of the Forest Service made a request on the Coast and Geodetic Survey, that certain control work be done by this Bureau in some of the forest reservations in Utah, Arizona, Oregon, and California. After consultation with officials of this Survey, and of the Forest Service, it was decided that, on account of the lack of Coast and Geodetic Survey funds which could be utilized to carry on the control in question, the Forest Service would place at the disposal of the Coast and Geodetic Survey an amount sufficient to start the control surveys before July 1, 1919.

After plans had been perfected at this office a party was organized in Arizona, and made the necessary reconnoissance. At the end of the fiscal year, observing for triangulation was in progress.

An officer took the field in Utah early in May, and made the necessary reconnoissance for the location of control stations for the Forest Service, and, at the end of the fiscal year, was ready to begin observing.

Valuable assistance was received from the members of the Forest Service in the reservations within which the work was done, in preparing and marking stations whose positions were to be determined.

Late in the fiscal year instructions were issued for a line of precise levels to extend southward from Kirk, Oreg., to Roseville, Calif., in the vicinity of Sacramento. At the end of the fiscal year the party was being organized and equipped. A subparty was organized to operate under the general direction of the chief of party.

Late in the fiscal year precise leveling was begun along the line between Troy and Whitehall, N. Y. By the end of the fiscal year this line was completed, and leveling had been begun in the vicinity of Rouses Point, N. Y., working westward along the international boundary. The completion of the leveling between Troy and Whitehall finished a new line of levels from Rouses Point to Troy. This line was begun several years ago, but the work was interrupted by the war.

A field party was engaged on the upper Chesapeake Bay during nearly the entire fiscal year in making a triangulation for the use of the officers of the ordnance department, United States Army, for the purpose of locating towers from which observations are made to determine the range of guns. This work was done at the request of officers at the Aberdeen Proving Ground, Md. During the progress of the field work, the chief of party was assisted by details of men and the assignment of transportation from the Aberdeen Proving Ground.

In the spring and early summer of 1919, a triangulation was made in the lower Potomac River for the purpose of determining geographic positions of range towers on a torpedo trial course. When the work was completed, this Bureau was requested to extend the triangulation to include the determination of the geographic positions of a number of stations which would be of value to the ordnance department of the Navy in determining the range of its guns.

At the request of the office of the Supervising Architect of the Treasury, a survey was made of the grounds in the rear of the hygienic laboratory, October 19 to 22, 1918. The work consisted of taking elevations at 20-foot intervals.

In July, 1918, at the request of the officer in charge of the rifle range at Congress Heights, D. C., the eastern boundary line of the rifle range reservation was surveyed and marked.

During the first half of the fiscal year 1919, two officers were engaged on the determination of the differences of longitude in Georgia, South Carolina, North Carolina, Virginia, and the District of Columbia. This work was done in connection with the precise traverse for the purpose of furnishing corrections to observed astronomical azimuths resulting from deflections of the vertical.

Late in the spring of 1919, the same officers began the determination of certain differences of longitude along the Rio Grande arc of primary triangulation, and were engaged on that work at the end of the fiscal year.

The chief of the division of geodesy was in the Army, with rank of major of engineers, from August 17, 1918, to February 28, 1919. During that time he was assigned to the division of military mapping of the Office of the Chief of Engineers. While with the Army his principal work was devising a special grid system for use in progressive mapping of the United States, and specifications for the special defense maps which, it is expected, will be needed by the Army at critical points along the coasts of the country.

When the chief of the division of geodesy returned to the Survey from the Army, he resumed his usual duties at this office. In addition he did considerable work with an interdepartmental committee on aerial surveying and mapping, and, also, the American sections of the proposed International Astronomical Union, and the International Geophysical Union. He was selected acting chairman of the American section of the proposed Geophysical Union and, on June 30, 1919, headed the geophysical delegation from the United States to the meeting of the International Research Council at Brussels, which was held, beginning July 18.

## DIVISION OF TERRESTRIAL MAGNETISM.

The duties of the chief of division include preparation of plans, estimates, and instructions for the field work; the inspection of the records as they are received; recommendations regarding the purchase, construction, and repair of instruments, and the construction and alteration of observatory buildings; supervision of the office computations, and preparation of results for publication; and discussion of results.

### MAGNETIC SURVEY.

As a result of conditions due to the war, the field work was very much curtailed. In the continuation of the magnetic survey of the United States, observations were made during the year at 77 stations in 11 States, of which 34 were new primary stations, 17 auxiliary stations, 22 repeat stations for the determination of secular change, and 4 new stations in old localities. Meridian lines were established, when they were requested by the local authorities.

### MAGNETIC OBSERVATORIES.

The observatories at Cheltenham, Md.; Vieques, P. R.; Tucson, Ariz,; Sitka, Alaska; and near Honolulu, Hawaii, were in operation throughout the year. Continuous photographic records were secured of the variations of declination, horizontal intensity, and vertical intensity. Absolute observations were made at least once a week, and scale-value determinations once a month. A week's observations usually consisted of four sets of declination, two sets of horizontal intensity, and two or more sets of dip.

The magnetic instruments used in the field work were standardized at Cheltenham. At Tucson comparisons were made with magnetometers Nos. 17 and 40, thus furnishing additional data regarding the relation between the Cheltenham and Tucson observatory instruments. A redetermination was made of the moment of inertia of the long magnet of the Tucson magnetometer, which explained the observed difference between the two standards. Upon the return of a magnetic observer from his field work in the interior of Alaska, he stopped at Sitka, and compared his instruments with those at that observatory. Advantage was taken of this comparison to secure additional data regarding the relation of the magnetic elements at the old and new sites of the absolute building.

A seismograph was operated continuously at each observatory, and earthquakes were recorded as follows: Cheltenham, 53; Tucson, 41; Porto Rico, 76; Sitka, 23; Honolulu, 157. Most of the large number recorded at Porto Rico were slight shocks following the great disturbance of October 11, 1918. This earthquake was so severe as temporarily to put out of adjustment some of the instruments, and, apparently, changed slightly the level of some of the piers.

The construction of a new building for office and quarters at Cheltenham was deferred, because of labor conditions. Some damage was done to the variation building by high winds, the force of the wind being sufficient to blow the boards off the eaves on the north side of the building.

Plans were prepared for the erection of a building for garage, shop, and pump house at Tucson, but the estimated cost was found to be too great to warrant its construction, and it was, therefore, decided to install a shop in the present garage, and erect a separate building for the storage of gasoline and kerosene.

## APPROPRIATIONS AND DISBURSEMENTS.

The appropriation made by Congress for the United States Coast and Geodetic Survey, in the sundry civil act for the fiscal year ended June 30, 1919, was $1,317,960, divided as follows:

| | |
|---|---:|
| Field expenses | $382,600 |
| Repairs and maintenance of vessels | 36,000 |
| Officers and men, vessels | 225,000 |
| Pay of field officers | 223,500 |
| Pay of office force | 253,860 |
| Office expenses | 80,000 |
| Offset attachment for lithographic press (reappropriated) | 3,000 |
| Two motor-driven lathes, at $750 | 1,500 |
| One new vessel to cost $354,000 | 50,000 |
| Four or more new launches | 62,500 |
| Total | 1,317,960 |

For the fiscal year ending June 30, 1920, the total amount appropriated is $1,614,280, and the items of appropriation are as follows:

| | |
|---|---|
| Field expenses | $494,600 |
| Repairs, vessels | 56,000 |
| Officers and men | 460,000 |
| Salaries, field | 256,900 |
| Office | 266,780 |
| Office expenses | 80,000 |
| Total | 1,614,280 |

## DETAILS OF FIELD OPERATIONS.

### HYDROGRAPHIC AND TOPOGRAPHIC WORK, ATLANTIC COAST.

### MAINE.

[J. H. HAWLEY.]

SUMMARY OF RESULTS.—Triangulation: 35 square miles of area covered, 1 signal pole erected, 5 stations in supplemental schemes occupied for horizontal measures, 10 geographic positions determined. Leveling: 2 permanent bench marks established, 1 mile of levels run. Hydrography: 220.6 square miles of area dragged, 410.9 miles run while dragging, 2,911 positions determined (double angles), 42 soundings made (on shoals), 1 tidal station established, 4 hydrographic sheets finished, scales 1:10,000, 1:20,000, 1:30,000, and 1:40,000.

On July 1, 1918, wire-drag party No. 2 was located at Eastport, Me., and engaged in the survey of Passamaquoddy Bay, having completed in June the survey of Western and Head Harbor Passages which form the approach to this bay. The work was carried on during July and August, and was completed on August 29. When there was an opportunity, without interfering with the drag work, triangulation and signal building were carried on in Friar Roads so that the party was prepared to drag this area as soon as the work in Passamaquoddy Bay was completed.

Drag work in Friar Roads was begun on August 30, and continued until September 16 when it was completed. During the course of this work advantage was taken of favorable weather to drag a strip about 2 miles wide in Grand Manan Channel from the northern limit of soundings off West Quoddy Head to a junction with the east limit of the work in Head Harbor Passage. The object of this work was to insure safe navigation for vessels along the east coast of Campobello Island in an area where very few soundings have been obtained.

The work in this region as finally completed embraces the survey of Passamaquoddy Bay and a continuous survey of its approaches from the northern limit of soundings in Grand Manan Channel, off West Quoddy Head, along the east coast of Campobello Island and through Head Harbor Passage, Friar Roads, and Western Passage. The survey covers a total area of 111.5 square statute miles.

Because of the great range of tide and strong currents in this region the progress of the work was necessarily slow. In the narrow channels forming the approach to Passamaquoddy Bay drag work could be done only at or near slack water. In the bay itself the currents were not strong enough to prevent work at any time, but cross currents due to the several small outlets of the bay resulted on several occasions in an abnormal lift which made it necessary to redrag some areas in order to obtain the drag depth desired. In the western part of the bay, for example, between Western Passage and the St. Croix River it was found that during flood tide the surface current ran to the northward while below the surface the river current continued to run south. When dragging with the flood tide, drag tests showed a lift of from 10 to 14 feet and it was finally necessary to drag this part of the bay during ebb tide when the tidal and river currents had the same direction.

An automatic tide gage was maintained at Eastport from June 28 until the survey was completed. During the course of the work in Passamaquoddy Bay secondary gages were operated at St. Andrews and Midjik Bluff, New Brunswick.

Signal building and triangulation for the work in Grand Manan Channel were executed by a party from the Geodetic Survey of Canada under the direction of H. F. J. Lambert. This party built and located signals on White Horse, Grand Manan, and Campobello Islands, and its work resulted in a valuable saving of time. The party is much indebted to Mr. Lambert for his prompt and efficient cooperation.

On September 17 and 18 the equipment was loaded on the launches, and on September 19 the party left Eastport to take up the survey of Machias Bay and approaches in accordance with instructions dated September 11, 1918. The party arrived at Jonesport, Me., on the afternoon of September 19, and established headquarters at that place. Drag work could not be started until September 25 because of weather conditions, and until that date the party was engaged in signal building and miscellaneous work.

Drag work was begun in this locality on September 25, and continued until November 9. A strip about 5 miles wide was dragged, extending from the Libby Islands westward to a point due south of Black Rock. The northern limit of this strip passes along the shore line in the vicinity of Moose Peak Lighthouse.

Whenever possible, soundings to supplement those shown on the chart were obtained by the tender which sounded at different buoys when the drag was under way. The depths in this locality are too great for the use of the hand lead, and it was, therefore, necessary to use a sounding machine. A registering sheave was furnished the party but no winding drum was available. A fairly satisfactory drum was accordingly improvised by attaching a large buoy hoist to a box and rearranging the gears to form the drum flanges. The size of the drum was enlarged to the size desired by winding rope on the shaft between the flanges. To wind this drum a buoy crank was cut down to give a short throw, and a brake was rigged to check the drum when the lead struck bottom; 390 soundings were obtained in this locality.

For the reduction of the drag work in this region, a tide gauge was established and maintained at Jonesport.

During October various members of the party were ill with the influenza which was then prevalent in Maine and the party was seriously short-handed for several weeks. Fortunately the work was in open deep water, and could be carried on with fewer men than are ordinarily necessary so that there was little delay as far as the drag work was concerned. It was necessary to work for some time without the larger tender, however, and fewer supplemental soundings were obtained than would have been secured with the normal number of men.

During the entire season a total area of 240 square statute miles was dragged, and 51 changes in the charted depths were found. These changes were reported from time to time during the season.

The launches *Pilot*, *Survey*, and *Edna M.* were used in this work. On November 9, on account of unfavorable weather, work was discontinued for the season.

In this work an improved semaphore machine was used. Improvements were also made in the method of attaching the buoys to the drag, permitting the new type of buoy to be used to advantage.

[J. H. HAWLEY.]

SUMMARY OF RESULTS.—Leveling: 14 permanent bench marks established, 2.5 miles of levels run. Hydrography: 7 tidal stations established, 6 current stations occupied.

On March 22, 1919, the chief of this party was relieved from duty in the office, and began the work of preparing for the transfer of launches from New York, N. Y., and Newport, R. I., to Norfolk, Va. This work was completed on April 27.

On arrival at Baltimore, Md., after completing the transfer of launches, he began the work of organizing a tidal and current survey party in accordance with instructions dated April 26, 1919. This party left Baltimore in the launches *Marindin* and *Mitchell* on May 6, arrived at Kittery Point, Me., and established headquarters on May 14.

On May 16 the chief of party proceeded to Portland, Me., in the launch *Marindin* and, after a delay of two days, due to stormy weather, established a current station on Portland light vessel on May 19, and then returned to Kittery Point. The launch *Mitchell* was left at Kittery Point during this period for painting and general overhauling.

On May 16, a member of the party left Kittery Point and proceeded to Camden, Me., where he installed a new engine in the launch *Edna M.*, and fitted this launch out for work. He then ran the launch to Kittery Point, arriving on May 27.

Current observations in Portsmouth Harbor and vicinity were started on May 21, and continued under very favorable weather conditions until June 12. Five stations were occupied.

A main tidal station was established in Pepperell Cove at Kittery Point on May 21, and tides were observed during the periods when current observations were in progress. Four supplemental tidal stations were also established and connected by simultaneous readings with the main station.

Bench marks were also established at the shipyard of the Atlantic Corporation on the west side of the river just above Portsmouth, and connected with the tide staff maintained by the company. Arrangements were made with the engineering division of the corporation to have observations made on the gauge in conjunction with observations at the main station.

Every effort was made to obtain tidal and current data from other organizations in the vicinity. The various gauges mentioned above were connected by spirit levels with 27 bench marks, 14 of which were standard bronze marks established by the party.

On June 12 the work in the vicinity of Portsmouth Harbor was completed, and on June 13 and 14 the wire-drag equipment in storage at Kittery Point was loaded on the launches and preparations made to change headquarters. Departure was prevented by thick fog until the afternoon of June 17, on which date the party left Kittery Point in the three launches, and proceeded to Cape Porpoise, Me.

Current observations from Cape Porpoise were prevented by bad weather until June 23, and this period of bad weather was utilized to install wire-drag equipment on the launches. On June 23, current observations were started at station No. 66 near whistle buoy "2CP" off Cape Porpoise, and continued for 51 consecutive hours until June 25. On June 26 a tidal station was established at Cape Porpoise Harbor.

The remainder of the month was taken up with office work on current and tidal records, installation of one-man control on the launches, and preparation of launches for wire-drag work to be started on July 1, 1919.

It was found to be impossible to hire tide observers for the work in Portsmouth Harbor, and the lack of an automatic tide gauge was keenly felt. Had one been available a considerably greater amount of tidal work could have been done.

The party was also somewhat handicapped when making continuous current observations by lack of quarters in the wire-drag launches that were used. As these launches have only two berths and are heated only by kerosene, they do not offer suitable accommodations for the five men that are necessary for continuous observations.

### MASSACHUSETTS.

[H. P. RITTER, July 1, 1918, to Apr. 21, 1919; J. A. DANIELS, Apr. 21, 1919, to June 24, 1919; W. C. HODGKINS, June 25, 1919, to June 30, 1919.]

An officer of the Survey has continued on duty throughout the year as Inspector for the New England coast, and in charge of the field station of the U. S. Coast and Geodetic Survey with an office in the customhouse at Boston, Mass.

Through the year, the best efforts of the inspector and all the facilities of the station were given to the assistance of the military departments of the Government in the prosecution of the war and in the various activities following the armistice. For such service, 259 copies of Coast and Geodetic Survey Charts were furnished to officers of the Army and Navy, besides 18 coast pilots, and 7 tide tables.

The station was also able to be of considerable assistance to the general public, the records showing that information was furnished to 1,064 applicants, that 179 publications of the Survey were distributed, and that 84 charts, 15 coast pilots, and 10 tide tables were sold.

A somewhat important feature of the work of the station was that of assisting the local agents for the sale of our publications to supply the need of the public by the transfer of items which they did not have in stock.

In the course of the year, 267 charts, 3 coast pilots, and 2 tide tables were thus transferred.

The station has also been an agency for the distribution and sale of the publications of the Bureau of Lighthouses. During the year, 114 copies of light or buoy lists were thus disposed of.

In addition to these office duties the inspector reported a supposed new shoal in the vicinity of the eastern entrance to Nantucket Sound and made frequent trips of inspection to points in the vicinity of Boston, in connection with topographic revision work. Many triangulation points were visited and most of the stations were recovered.

Under the direction of the inspector extensive topographic revision in the vicinity of Lynn, Salem, and Marblehead was executed by officers detailed for the purpose.

In the autumn of 1918 the inspector installed apparatus for the observation of currents upon the light vessels stationed at Pollock Rip Slue, the Stone Horse Shoal, and Nantucket Shoals; and in March, 1919, upon the temporary light vessel *Easthampton*, stationed at the northern end of Stellwagen Bank.

During the winter six officers and draftsmen were furnished office space and necessary facilities for the completion of the field records of wire-drag parties Nos. 1, 2, and 5.

The topographic chart revision and the reduction of wire-drag records were under the direction of the inspector until February 1, 1919, when they were transferred to another officer, with headquarters at Salem, Mass.

During the greater part of the year a considerable part of the office space of the station was occupied by the force of the office of Inspection of Engineering Material, United States Navy, in compliance with the request of the inspector in charge of that office.

Similar assistance was given the office of the United States Civil Service Commission, whose room adjoined that of the field station.

With the view to acquainting the public with the existence and facilities of the station, most of the local yacht clubs were visited by the inspector, who furnished them with sundry publications besides general information.

[JOHN A. DANIELS.]

SUMMARY OF RESULTS.—Triangulation: 40 square miles of area covered, 2 signal poles erected, 9 stations in supplemental schemes occupied for horizontal measures, 55 geographic positions determined. Topography: 45 square miles of area surveyed, 48 miles of general coast line surveyed, 56 miles of shore line of rivers surveyed, 9 miles of shore line of creeks surveyed, 11 miles of shore line of ponds surveyed, 380 miles of roads surveyed, 4 topographic sheets finished, scale 1:10,000.

On January 24, 1919, J. A. Daniels relieved H. P. Ritter of the field work of revising the topography and triangulation of the north shore of Massachusetts Bay from the latitude of Grover's cliff northeastward to and including Manchester Harbor.

This work had been begun in July, 1918. Old triangulation points had been recovered, various plans and maps had been obtained from town and city surveyors, and these had been transferred to copies of the original sheets, and some original revision work had been done in the vicinity of Marblehead Neck. Enough had been accomplished to show that an extensive revision of the whole area was necessary.

Four sheets lettered A, B, C, and D, from south to north, were laid out upon a scale of 1:10,000, to include the area specified. During the bad weather of February and March all the previous surveys and information from various sources were transferred to these sheets in pencil. Plane-table work for verification and correction was begun as soon as weather permitted, and was pushed every good day until it was completed. A great deal of intermediate detail work was paced and sketched in notebooks and then transferred to the sheets. By following this method it was possible to work on many days when the sheets could not be taken out, and it made possible the utilization of sketchers on good days. The inking of the sheets was done as soon as the details were secured and the existing work was corrected or verified. By following this method the party was always busy regardless of weather conditions, and the office work was very nearly up to date at all times. While the sheets are revision sheets they have all the value of a complete resurvey—as to completeness and accuracy. The only exception is in the matter of contours and elevations. This phase was not touched upon, as it was concluded that the old contour system was as complete and accurate as any that could be produced and that changes of contour were not appreciable.

The objects that had been located by the wire-drag parties of 1915–16 supplied the principal control, although a few older points were recovered and used. Mr. Ritter had visited and recovered a large number of triangulation points, and had secured information that was very valuable. The control was adequate without additional triangulation, and the triangulation done was for the sole purpose of locating prominent objects for use upon the chart.

### CONNECTICUT, NEW YORK, AND RHODE ISLAND.

[J. A. DANIELS.]

**SUMMARY OF RESULTS.**—Triangulation: 1½ square miles of area covered, 5 signal piles erected, 3 stations in main scheme occupied for horizontal measures, 13 geographic positions determined. Leveling: 2 miles of levels run. Topography: ½ mile of shore line run. Hydrography: 138.2 square miles of area dragged, 0.25 square mile of area sounded, 211 miles run while dragging, 18.4 miles run while sounding, 8,669 angles measured while dragging, 341 positions determined (double angles) while sounding, 69 retained soundings, 1,687 soundings made, one drag sheet finished; scales of hydrographic sheets, one 1:2,000, two 1:20,000, two 1:50,000.

Wire-drag work in Block Island Sound and Fishers Island Sound was in progress at the beginning of the fiscal year, and was continued until November 14.

No extensive scheme of triangulation was required for this work. One new station was established and marked on Block Island, R. I. Observations were made to locate the flagpole at the Block Island naval base headquarters, and several other natural objects were located for use as signals in the hydrographic and wire-drag work. The flagpole mentioned was located at the request of the commander of the naval base. Observations were also made to determine the north range points of the Block Island trial course. These were requested by the chief of wire-drag party No. 1. Several old stations were recovered for these purposes.

A small system of plane-table triangulation was made for the location of signals to control the hydrographic survey of the entrance to Great Salt Pond. Fourteen objects were determined for this purpose. In connection with this work the shore line at the entrance was rerun.

The sounding work accomplished was done at the request of the naval authorities, and consisted of a complete resurvey of the entrance to Great Salt Pond, Block Island, on a scale of 1:2,000. This survey made known the fact that the north side of the channel has shoaled considerably through the collection of sand and gravel. The safe depth in the channel has become narrowed on this account. No other difference in depth was noted.

The sounding was done from a pulling boat loaned to the party for the purpose by the commander of the naval base.

In the vicinity of Block Island, R. I., the wire-drag work begun in the first part of the summer by party No. 1 was extended to the westward and northward to join additional work that was done to the eastward of the island. In the vicinity of the Sandy Point bell buoy to the northward of the island unusually troublesome currents were encountered. Much of the irregularity was due to wind action, but counter and eddy currents were also noted. To find the current flowing normally any day and in the direction predicted was an exceptional occurrence. This handicap, together with the irregularities in depth, not shown on the chart, made this an exceptionally difficult area to drag. Approximately 100 square miles of area were covered in the immediate vicinity of the island. This area connects with areas previously dragged to the westward of the island. One dangerous shoal was located, this being a bowlder with a depth of 20 feet, found off the northeast point of the island. The work was done on a scale of 1:20,000 in the areas close to the island and 1:50,000 in the offshore areas.

In the vicinity of Southwest Ledge an examination was made in order to locate the shoal upon which the steamer *Allaquash* was reported to have struck on July 30, 1919. No shoal was found at the point indicated, and it was concluded that the steamer was in error in reckoning, or else had struck a piece of submerged wreckage that had been carried away subsequently by the tidal currents. The work in this vicinity was done on a scale of 1:20,000, but was plotted upon an existing smooth sheet which has a scale of 1:50,000.

On November 13 the party was transferred from Block Island to Noank, Conn., and the subsequent work was done in Fishers Island Sound or in the western part of Block Island Sound. After this transfer it was possible to work in the exposed waters of Block Island Sound during clear, calm days, and to utilize less favorable days for work in the sheltered waters of Fishers Island Sound. Approximately 40 square miles of area were covered and 7 dangerous shoals located in this vicinity. Connections were made with the work of other parties in the vicinity of New London and the Race.

It was necessary on account of the country being at war to maintain close cooperation with the naval authorities in carrying on the wire-drag work. This proved to be a pleasent duty in this instance. The naval commander at Block Island did everything in his power to further the progress of the work. The carpenter and machine shops were made available for the uses of the party. All kinds of supplies, including gasoline and engine oils, were transferred to the party whenever requested. The use of a whaleboat for sounding in the harbor and of various tools that were lacking in the party equipment were readily secured. The party was given the use of an office within the naval headquarters building for the greater part of the season—in fact, everything possible was done for the comfort and convenience of the party and for the furtherance of the work.

Close cooperation was maintained with wire-drag party No. 1 of this service, stationed at Stonington, Conn. The shortage of wire-drag equipment due to delayed deliveries because of the war made it necessary to exchange various items in order to keep both parties as completely supplied as was possible. These exchanges were made with a cordial spirit of cooperation, and resulted in increased output of both parties. An advantageous division of the work in Block Island Sound was also made, which resulted in the connection of the areas surveyed by the two parties without loss of time or duplication of work.

The *Norman 2*, chartered as guiding launch, the *Annie T. Mack*, chartered as end launch, and the *Chelsea E.*, a Block Island fishing boat chartered as tender, gave satisfactory service.

Aluminum floats, designed and purchased by J. H. Peters in 1917, were used in part throughout the season. They showed no signs of deterioration because of the action of the salt water; unless previously bruised, they readily withstood the pressure of the deeper depths dragged; and they were very convenient to handle because of light weight and small volume. If proper facilities are provided to prevent bruising these floats when they are taken aboard, there is no reason why they should not last indefinitely. This is an important point, however, as even small bruises so weaken them that they collapse or fill with water when deeply submerged. Our experience with them during the season left no doubt that they are much the best design yet used for the purpose, and their general adoption is strongly recommended.

### RHODE ISLAND.

[F. B. T. SIEMS.]

SUMMARY OF RESULTS.—Hydrography: 1 automatic tide gauge established, 3 tide stations established, 5 current stations occupied.

Under instructions from the Superintendent dated May 21, 1919, a party for tidal and current surveys was organized at Baltimore, Md., for work on the coast in the vicinity of Point Judith, R. I.

Between May 21 and June 3, 1919, the newly-built launches *Rodgers* and *Ogden* were outfitted for making the trip to the New England coast, and for survey purposes, and on June 4 the party and launches left Baltimore, Md., for the field of work.

It was found impracticable to use Point Judith Harbor of Refuge as a base for survey operations, making it necessary to stop at Block Island where the party arrived June 11.

Work was begun at once, and was in progress at the close of the fiscal year.

### CONNECTICUT, NEW YORK, AND RHODE ISLAND.

[F. B. T. SIEMS.]

SUMMARY OF RESULTS.—Triangulation: 4 signal poles erected, 6 stations in supplemental schemes occupied for horizontal measures, 10 stations occupied for vertical measures. Leveling: 4 permanent bench marks established. Hydrography (wire-drag work): 97 square miles of area dragged, 180 miles run while dragging, 18 rocks and shoals discovered, 247 soundings made (over shoals), 1 tide station established.

After completing wire-drag surveys and current observations off the west coast of Block Island during the early part of July, the party was transferred to Stonington, Conn., on July 6, 1918, to conduct wire-drag surveys in Long Island Sound, Block Island Sound, and Fishers Island Sound.

On account of the strong tidal currents and exposed waters of the areas named above, especially in the extreme eastern part of Long Island Sound and adjoining portions of Block Island Sound, the need of efficient launches for dragging is of primary importance. A good part of the day can be lost to field work by temporary engine failure. The drag may be swept away from the area desired to be covered, by strong currents, and make it impossible to return to the area unless the drag is taken up and again set out. Thus nothing is accomplished up to the time a second or third trial is made.

As mentioned in the previous report, the party was handicapped in the use of inefficient launches, one of which was the end launch chartered for the party at the beginning of the season, and the other was temporarily hired. It was impracticable to continue to work with the underpowered and very poorly designed end launch in the new locality, and efforts were therefore made to replace this launch and the guide launch, which the owner failed to deliver to the party, by other launches.

At this time a great many launches were turned over to the Navy, also many were being used for fishing or other occupations; therefore few, if any, suitable launches for wire-drag work could be hired. A great deal of time was consequently lost to field work during July in searching for launches.

Finally, after considerable trouble, the best two launches that could be obtained under the circumstances were accepted the latter part of July. Although of sufficient power, they were far from meeting the requirements of the work in this locality. Both of the launches later proved to be more or less unsatisfactory on account of engine trouble. It was necessary to carry nearly all the wire-drag gear on the guide launch, on account of lack of space in the end launch, losing considerable time each day in setting out and taking up the drag.

Field work was resumed on August 3, after outfitting the newly hired launches. The work in general was planned so as to take advantage, if possible, of fair currents in going to and from the working grounds, and also in dragging. Dragging was in progress in Long Island Sound and Block Island Sound during August, September, and part of October. The work in Fishers Island Sound and off New London Harbor was accomplished in October and November, when the weather restricted work in the open waters.

The area covered by the wire drag in Block Island Sound is roughly outlined by an area extending south from the 7-fathom curve on the north side of the sound from Mount Prospect, Fishers Island, to Noyes Neck, R. I., to about halfway across Block Island Sound. It forms a junction in part on the east with the work done by the wire-drag party operating westward from Block Island. The work inshore and near the Race was hampered by heavy lobster gear which owners, upon request, failed to remove. Some uncharted rocky ledges were discovered inshore; the areas offshore were found free from dangers. The supposed wreck of the steamer *Larchmont* was located off Watch Hill Point, in 20 fathoms of water, and has a least safe depth of about 72 feet over it. A shoal sand ridge about 4 miles northeast of Cerebus Shoal was found to have about 14 feet less depth than soundings obtained by former surveys.

The area dragged in Long Island Sound extended eastward from meridian 72° 13′ directly north of Plum and Gull Islands to a junction with completed work. No dangers were found in this area. The work was exceedingly difficult on account of very strong currents, and it was at times impossible to control the drag. Two small undragged areas in the Race were covered during short periods of least current.

The dragging in the approach to New London Harbor, which the Navy Department requested, and covered by supplemental instructions from the Superintendent dated August 22, 1918, was accomplished. No natural dangers were found to exist in this area, but several wrecks of vessels were discovered.

In all of the above work the maximum effective depth was in general 100 feet, and in depths of 10 to 20 fathoms the waters were dragged 5 to 20 feet off the bottom. In depths less than 10 fathoms, dragging was done 3 to 6 feet off the bottom.

An area of about 4 square miles off Stonington Breakwater, Fishers Island Sound, was dragged to a maximum effective depth of 35 feet, and within 3 feet of the bottom in lesser depths. A very short drag was used for this work, and in order to have time to maneuver the launch over the intricate channels, dragging against the current with the short drag was found necessary. Ranges, consisting of buoyed flags and placed in position so as to guide the launches in covering certain areas, were found to be very helpful. In order to drag this area it was necessary to remove a large number of lobster pots.

The work was well controlled by numerous triangulation stations, some of which were established by the party. Practically all the signals used were located by triangulation.

Tides were read at Little Gull Island and at Stonington, Conn., for the reduction of drag depths and soundings.

### NEW YORK.

[J. H. PETERS, Commanding Steamer *Ranger*.]

SUMMARY OF RESULTS.—Triangulation: 9.7 square miles of area covered, 6 stations in supplemental schemes occupied for horizontal measures, 25 geographic positions determined. Leveling: 3 permanent bench marks established, 0.1 mile of levels run. Topography: 0.3 mile of general coast line run. Hydrography: 0.4 square mile of area sounded, 22.1 miles run while sounding, 184 positions determined (double angles), 1,373 soundings made, 2 tide stations established, 1 hydrographic sheet finished, scale 1 : 10,000.

Between April 14 and June 30, 1919, a hydrographic survey and such triangulation and topography as was necessary to control the hydrography was made of the southeast side of Staten Island between the foot of New Dorp Lane and Midland Beach, in accordance with instructions dated April 12, 1919.

The triangulation necessary to control a hydrographic and topographic resurvey of Gravesend Bay and adjacent territory, New York Harbor, was done in accordance with instructions dated May 10, 1919. The hydrography covered by these instructions was not done during this fiscal year, as it was understood not to be immediately necessary and was postponed until the small boats for the *Ranger* would be available, when the hydrography could be completed at less cost.

[ISAAC WINSTON.]

Inspection duty for the region between Narragansett and Delaware Bays was continued by an officer who is in charge of a field station of the Survey with an office in the customhouse, New York City.

On July 1, 1918, the inspector was in the field on the coast of New Jersey engaged in determining the geographic positions of certain towers used in connection with range firing, which had been requested by the commanding officer of the Sandy Hook Proving Ground. This work was completed on July 10.

On July 24, 25, and 26 an inspection was made with officers of the Army Engineers of the Eastern Department of the condition of the triangulation stations on the western end of Long Island.

On August 15 and 16 the inspector determined the geographic positions of North and South Sandy Hook beacons.

Other visits to Sandy Hook in connection with this work were made on August 20 and 28.

A day was spent in September on reconnoissance at Fort Tilden, N. Y., with an engineer officer of the Eastern Department.

In the latter part of October the electric tide indicator which had been in operation for many years in the Maritime Exchange was dismantled, funds for its repair and operation not being available.

A stock of charts and nautical publications was kept on hand at the field station for reference and sale.

The number of demands upon the inspector for information covering a wide range continues to increase, and the usefulness of the field station is becoming more widely recognized. Many Army and Navy officers called for information, and numerous charts and publications were furnished to meet emergency demands.

Cordial relations and cooperation were maintained with the branch hydrographic office at New York.

Copies of tidal data and tables giving the time of sunrise, sunset, moonrise, and moonset were furnished for publication in local tide calendars, in 16 newspapers, and in Eldridge's tide book.

The inspector has acted as agent for sale of publications of the Bureau of Lighthouses and for distribution of pilot rules for inland waters.

A self-registering tide gauge was installed at the shipyard of the Submarine Boat Corporation at Port Newark, N. J., in February, and has been in operation since that time.

In March current measuring apparatus was placed on two temporary light vessels maintained by the Navy off the entrance to New York Harbor, and observers were instructed in the methods of observing currents.

In March negotiations were begun for the transfer of several vessels from the Navy to the Coast and Geodetic Survey.

On May 15 the rooms occupied by the field station were temporarily placed at the disposal of the Commissioner of Lighthouses for the meeting of a board appointed to consider the question of placing a light vessel off Barnegat Inlet, N. J.

In June arrangements were made for the transfer of the launch *Elsie III* from Boston to New York, and the launch was afterwards brought to New York by an officer detailed for the purpose.

Preliminary plans for a tide and current survey of New York Harbor and vicinity were discussed with the engineer officer in charge of the deepening of the channel through East River, and mutual cooperation and assistance were secured.

Copies of tide tables and times of sunrise and sunset for 1920, corrected to conform to the daylight-saving law, were prepared for the publishers of certain calendars.

Tidal tabulations were made for various ports.

### NEW JERSEY.

[C. G. QUILLIAN.]

SUMMARY OF RESULTS.—Triangulation: 7 stations occupied for horizontal measures, 3 triangulation stations recovered, 75 geographic positions determined.

Between June 10 and June 30, 1919, a field officer was engaged in the determination by triangulation of control points for a revision of topography by aerial photography to be made by the Army. He recovered 3 triangulation points, occupied 7 stations, and located approximately 75 points for the aerial survey.

### DELAWARE.

[J. S. S. JONES.]

In the latter part of August, 1918, an inspection was made at Lewes, Del., for the selection of a suitable site for the erection of an automatic tide gauge near Deleware Breakwater.

Four localities were visited, three of which proved unsuitable for the purpose intended. The site selected is on a pier under the charge of the Corps of Engineers, United States Army, on the outer end of which is a small building used as a shelter by the keeper of the lighthouse depot. This is now used to house the gauge and apparatus.

On January 9, 1919, the necessary preliminary arrangements having been made, the installation of the gauge was begun. The northwest corner of the building was chosen as the site of the gauge.

When the tide staff had been placed in position a double line of levels was run from the staff to five old and six new bench marks. The float well was placed in position, a box shelter constructed over the top of the well, the gauge set up and put in operation, and the observer instructed in his duties.

### DELAWARE, NEW JERSEY, VIRGINIA, NORTH CAROLINA, SOUTH CAROLINA, AND GEORGIA.

[H. A. MARMER.]

In July, 1918, arrangements were made for installing on light vessels in the third, fifth, and sixth lighthouse districts, the apparatus necessary for a series of current observations to be made in various localities along the Atlantic coast.

The current apparatus had been shipped to the various lighthouse depots considerably in advance of the probable date of the sailing of a tender, so that no delay was caused by the nonarrival of a shipment. The various light vessels were visited by the observer on the regular trips of the lighthouse tenders, the apparatus installed and the necessary instructions given for operating it.

Apparatus was installed on the following light vessels: Diamond Shoals Light Vessel, Cape Lookout Shoals Light Vessel, Frying Pan Shoals Light

Vessel, Brunswick Light Vessel, Winter Quarter Shoals Light Vessel, Overfalls Light Vessel, and Northeast End Light Vessel.

In February, 1919, apparatus was installed and observers instructed on the temporary light vessels *Falcon*, *Long Island*, *Owl*, and *Brant*.

### VIRGINIA.

[E. B. LATHAM, Commanding Schooner *Matchless*.]

SUMMARY OF RESULTS.—Triangulation: 77 square miles of area covered, 20 signal poles erected, 11 stations in main scheme occupied for horizontal measures, 27 geographic positions determined. Leveling: 3 miles of levels run, 7 permanent bench marks established. Topography: 2 square miles of area surveyed. Hydrography: 65 square miles of area surveyed, 332.4 miles run while sounding, 1,270 positions determined (double angles), 12,558 soundings made, 4 tidal stations established, 6 current stations established, 1 hydrographic sheet finished, scale 1:20,000.

Between July 1 and September 18 the *Matchless* was engaged in surveys in York River, Chesapeake Bay, and Back River, all in Virginia.

The work requested by the Navy Department in York River, and soundings to verify depths, etc., indicated by previous surveys, was completed September 3, 1918.

The location of signals and other objects for the use of the Atlantic Fleet was transmitted to the commander in chief of the Atlantic Fleet and the commander of naval base No. 2. This consisted of a tracing from the confidential chart of this region (published by the Hydrographic Office), on which was shown the position of the objects requested by the Navy.

In addition to this tracing, a list was made showing the names and positions in degrees, minutes, and meters, and a brief description of each object. A copy of the latter was sent to the office. Every assistance possible was rendered by the naval authorities.

The surveys at the naval oil base afterwards requested by the Navy Department were completed within the time required by the naval authorities.

On September 3 all the work in York River and approaches, except three current stations, had been completed.

The *Matchless* was moved on September 5 from Sedger Creek to mid-channel abreast of the beacon in York River. Two of the launches were posted, one in Mobjack Bay and one in Poquoson River. Currents were observed from the ship and each of the launches, beginning at 10 a. m., Thursday, September 5. Heavy weather interrupted the observations at 7 a. m., Saturday, September 7, and the ship was put under way at 12 noon on that date for Back River. A rough passage was made with the wind northwest hauling to northeast.

After passing the bar at Back River, the tide and wind were too much for the launches to make headway against, and after four attempts to pass the turn in the channel at the lower Back River Beacon the ship was anchored to await slack water.

At 6 p. m., September 7, the ship was under way, and passed to a safe anchorage into Back River off Messick Point. Eight feet is the best water in the crossover below the Upper Back River Beacon, and the ship touched lightly in passing in.

On Monday the anchorage was shifted to off Amory's wharf, Back River.

On this date field operations were begun with two parties searching for old triangulation stations, and the commanding officer going to Langley Field headquarters to arrange for supplies, getting fresh water, and for information, etc.

Signals were erected, and the observations in the triangulation begun on September 11. This triangulation was necessary to determine signals for use off and in Back River, and to determine certain objects (landmarks, etc.) to be shown on the new editions of charts for this region.

Boat sheets, showing positions of sounding lines of previous surveys and old depths for comparison of the work of 1918 with these old surveys, were prepared, and sounding operations were begun on September 16.

[C. H. OBER, Commanding Steamer *Hydrographer*.]

SUMMARY OF RESULTS.—Leveling: 10 miles of levels run. Hydrography: 435 square miles of area covered, 2,277.3 miles run while sounding, 6,560 positions determined (double angles), 34,092 soundings made, 6 tide stations established, 10 current stations occupied, 2 hydrographic sheets finished, scales 1:40,000 and 1:80,000.

On June 30, 1918, the hydrographic survey of lower Chesapeake Bay was in progress.

The work done was included on two hydrographic sheets, one extending from Lynnhaven Roads to latitude 37° 08′ between Cape Henry and Thimble

Shoal Lighthouse and the other from latitude 37° 08′ to Wolf Trap Lighthouse. From the eastern limit of longitude 76° 04′ west to the western limit of a line drawn from York River to Wolf Trap.

Field work by the vessel was closed October 31, but tidal readings were continued until November 16, 1918.

[L. A. POTTER, Commanding Schooner *Matchless*, Sept. 18, 1918, to Apr. 30, 1919; Commanding Steamer *Onward*, May 1 to June 30, 1919.]

SUMMARY OF RESULTS.—Triangulation: 142 square miles of area covered, 4 signal poles erected, 5 observing tripods and scaffolds built, 17 stations in main scheme occupied for horizontal measures, 92 geographic positions determined. Leveling: 23 permanent bench marks established, 7 miles of levels run. Topography: 46.5 miles of area surveyed, 37 miles of general coast line surveyed, 10 miles of shore line of rivers surveyed, 40 miles of shore line of creeks surveyed, 229.5 miles of roads surveyed; scale of topographic sheet 1:10,000. Hydrography: 82 square miles of area covered, 1,262 miles run while sounding, 6,435 positions determined (double angles), 42,880 soundings made, 13 tide stations established, and 7 current stations occupied, 3 hydrographic sheets finished; scales of hydrographic sheets 1:20,000, 1:10,000, and 1:5,000.

On September 18, when the command of the schooner *Matchless* was transferred, the vessel was at anchor in Back River. The signals for the triangulation in Back River were already erected, and one day of hydrography on the hydrographic sheet, extending from York River to Hampton Roads, had been done. Work was continued on the hydrography and triangulation in accordance with orders previously issued, and on October 4 the *Matchless* shifted from an anchorage in Back River to a berth in Hampton Creek, where she lay until the end of the calendar year.

The triangulation in Back River necessary to locate prominent objects and signals for the control of the hydrography was completed before leaving that locality. Observations were also taken to locate Thimble Shoal Lighthouse and several prominent objects near the entrance to Hampton Roads. Seven stations in the main scheme and 12 intersection stations were located in connection with the work from York River to Hampton Roads.

A special development of Back River entrance was made, and the positions of the aids to navigation, and a copy of the survey of the entrance were furnished to the superintendent of lighthouses, Baltimore, Md. The hydrography was extended eastward to a junction with the work done by the *Hydrographer*, and southward to the shore of Willoughby Spit, to cover the area south of Thimble Shoal Channel, which has been used as a dumping ground. Work on the sheet extending from York River to Hampton Roads was completed November 14.

In accordance with instructions dated November 1, a reconnoissance of Hampton Roads, Chuckatuck Creek, and Elizabeth River and tributaries was at once taken up to obtain information as to the necessity of further surveys. This work was completed, and a report submitted November 8, showing the necessity for complete surveys of the whole area.

In accordance with instructions dated November 14, work on a hydrographic and topographic survey of Hampton Roads was at once taken up. This work was in progress at the end of the calendar year. Signals necessary to the control of the hydrography and topography were erected, and observations made for their location and the location of prominent objects, of which many were uncharted. Three stations in the main scheme and about 25 prominent objects were located.

The commanding officer conferred frequently with the U. S. Engineers, the officials at the naval base, and others in order to coordinate the survey work and make the results as nearly complete as possible.

On January 1, work was in progress on the hydrographic, topographic, tidal, and current survey of Hampton Roads and vicinity, the party having headquarters at Hampton, Va. This work was continued throughout the remainder of the fiscal year and was in progress on June 30. A topographic sheet covering the north side of Hampton Roads and two sheets on the south side were completed. A hydrographic sheet covering the main part of Hampton Roads southward to Craney Island Flats was also completed. Seven current and seven tidal stations were occupied.

The triangulation was continued for the purpose of furnishing control for the hydrography and topography, and for the location of prominent objects for the charts. A special effort was made to make the list of prominent objects for the charts complete, and the legends selected were such as to make the objects easily distinguishable. A special effort was also made to verify the descriptions of old stations, and furnish descriptions, not only of all new stations determined, but of all old stations recovered for which no descriptions exist. Three main-scheme stations and 42 prominent objects were determined by triangulation. All new stations were described, and recovery noted for 90 old stations prepared.

A large part of the time of the party was devoted to miscellaneous work in connection with transfer of vessels and launches from the Navy Department to the Coast and Geodetic Survey, shipment of launches to the Pacific coast, care and overhauling of vessels and equipment, and work in connection with condemnation and sale of the schooner *Matchless*.

The steamer *Onward* was received from the Navy Department on April 18, and brought from Norfolk to Hampton April 19. Work was at once started on cleaning, painting, and overhauling the vessel, to fit her for receipt of the personnel and equipment and to fit her for survey purposes. The vessel was placed in commission May 1, but work on her was continued, simultaneously with the field work, and was still in progress on June 30.

The launch *Almax II* was taken over from the Navy Department April 28, and the *Scandinavia* May 21. In addition to these, five others—the *Helianthus, Wildcat, Lydia III, Mikawe*, and *Audwin II*, taken over from the Navy by other officers—were turned over to the commanding officer of the steamer *Onward* for shipment to the Pacific coast. The *Helianthus, Audwin II*, and *Almax II* were shipped before the close of the fiscal year.

The commanding officer served as a member of the board of appraisal of the schooner *Matchless*, the report of which was submitted April 26. The *Matchless* was placed out of commission April 30, personnel and equipment being transferred to the steamer *Onward*. She was advertised for sale May 19, sold June 16, and delivered to the buyers June 30.

Under orders dated March 22, the commanding officer was instructed to cooperate with the commanding officer of the *Isis* in making arrangements for the shipment of launches to the Pacific coast on a Navy transport. Arrangements were successfully made, and three launches—the *Helianthus, Almax II*, and *Audwin II* were shipped on the U. S. S. *Huston*, leaving Norfolk April 12.

[H. A. SERAN, Commanding Steamer *Bache*.]

SUMMARY OF RESULTS.—Hydrography: 6 tall hydrographic signals built, total height 824 feet.

During the period from March 31, 1919, to June 20, 1919, the steamer *Bache* was being repaired at the Coast Guard station, Arundel Cove, Md., Speddins Shipbuilding Co., Baltimore, and at the Norfolk Navy Yard. An officer was assigned to act as the representative of the Survey while these repairs were in progress.

On June 22 the vessel was turned over to the Survey, although the Navy Department had yet to finish certain items of repairs and furnish a sounding machine.

From June 20 to June 30 the vessel was at the navy yard; Norfolk, Va., obtaining supplies, preparing buoys for use as signals on the offshore hydrography, and installing a sounding machine.

Arrangements were made with the superintendent of lighthouses of the fifth lighthouse district for the loan of six second-class, tall-type can buoys to be used as offshore signals in accordance with previous Coast Survey practice. As the Lighthouse Service could not furnish the necessary chain and anchoring gear, arrangements were made with the Bureau of Ordinance, Navy Department, for the loan of such mooring material as was necessary to take the place of chain, etc. This material had been used in connection with the defense net across the Capes of the Chesapeake.

As the buoys for offshore signals were to be placed in the fairway to the channel at the approaches to Chespeake Bay, it was decided to equip each of the buoys with a light similar to the temporary light established at times by the Lighthouse Service. Specifications were drawn up, advertised, and a contract let with the Alexander Millburn Co., of Baltimore, Md., to furnish six such lights. The lights consist of a marine lantern, with fresnal lens, equipped so as to show a steady white light about 8 feet above the top of the buoy and inside the superstructure. The gas for the light is furnished by a Prest-O-Lite tank and reduced to suitable pressure. The lantern and tank are securely fastened to a frame which is to be fastened to the superstructure on the buoy with eight braces.

In order to start field work with little delay after the transfer of the vessel from the Navy, a subparty was organized. This party built the signals necessary for the work while the vessel was being repaired at Baltimore and Norfolk.

Two 100-foot signals were erected, one near the site of Ship Shoal 3. 1915, about 5 miles north of Cape Charles and at the northern limit of the work, and the other on the site of Mink Hill, 1915. It was the intention to build a third 100-foot signal at or near the site of Bel, 1915, but as this part of the island is suffering greatly from inroads from the sea, anchors for the guys could not be placed. This part of Smith Island is entirely under water at high tide at the present time. To have built a tall signal at this point would have required more money than was available at that time. A 40-foot signal without far-reaching guys was erected instead.

In addition to the two tall signals and the 40-foot signal mentioned in the preceding paragraph, the subparty built three more 40-foot signals on Smith Island at or near the sites of previous signals.

The officer in charge of the subparty left Baltimore on May 15, and reported on board the *Bache* at Norfolk, Va., at the completion of the signal building on June 20. The greatest difficulty experienced by the subparty was the transporting of the materials for the signals to the various sites.

### SOUTH CAROLINA.

[A. C. WITHERSPOON.]

**SUMMARY OF RESULTS.—Triangulation: 21.9 square miles of area covered, 3 signal poles erected, 12 stations in supplemental schemes occupied for horizontal measures, 31 geographic positions determined.**

Between February 26 and April 22, 1919, a revision was made of the triangulation in the vicinity of Charleston, S. C., in order to make available for use on a new edition of Chart 445, the results of a number of recent surveys by the United States Engineers and others, and to locate prominent points of a permanent nature that could be used as landmarks for navigation purposes.

Copies of surveys and maps by the United States Engineers, naval authorities, transportation companies, and local municipal officers showing the most recent soundings and changes in shore line due to new construction or natural changes, were obtained.

Eleven prominent points were determined by triangulation for use as landmarks.

### GEORGIA.

[W. H. KEARNS.]

In accordance with a request from the construction division of the War Department a hydrographic survey was made of the Turtle River, Ga., from a point near the Southern docks, which was the limit of a recent survey, to a point beyond Crispen Island.

The constructing quartermaster of the picric acid plant at Brunswick furnished quarters for the chief of party and his assistant, and supplied the necessary laborers and material, and a launch for the transportation of the party.

The picric acid plant was situated near Southern Junction railroad station about 8 miles north of Brunswick, and about 2 miles west of the Turtle River. It occupied about 6 square miles of woodland and swamp land between Turtle River on the southwest and Southern Junction on the northeast.

Crispen Island is a low lying, sparsely wooded island on the east shore of the Turtle River about 3½ miles north of the Southern Railway docks. On this island were to have been placed warehouses and docks, and a roadway was to have been built over the marsh from the plant to the docks.

In the Turtle River between this island and the Southern Railway docks the chart showed depths of 25 feet with places of 15 and 18 feet, and it was requested that since the previous survey, which was made in 1856, was more or less preliminary, that a complete survey of the river be made from Southern Railway docks to beyond Crispen Island so that the amount of dredging could be ascertained, and that ships drawing 25 feet of water could proceed up to Crispen Island.

The launch *Polaris* furnished by the constructing quartermaster was found unsatisfactory. Another boat was hired from the fishing fleet at Brunswick which proved more satisfactory.

The work was begun with all possible dispatch, and an attempt was made to bring the triangulation up from Brunswick and sound out the shoal area lying off Little Crispen Island as rapidly as possible so that dredging could be done immediately. However, shortly ofter the signing of the armistice, orders were received from the War Department to close down the plant, and the work of building the road to Crispen Island was stopped. The preparations for the building of the docks at Crispen Island were also stopped, and therefore the immediate need for the survey ceased. The constructing quartermaster, however, still thought it advisable to survey the river, and continued to finance the work.

It was necessary to extend the triangulation up from Brunswick, and therefore stations Bly, Buz, and S. E. Base, which were old established stations, were recovered. The scheme of triangulation consisted of five quadrilaterals. Nine new stations were established as the main-scheme stations and were marked. Five stations were marked by standard disk stations and reference marks, namely, Road, Tel, Hen, Dil, and Creek. Four other stations were marked by a copper nail in a 2 by 4 post sunk flush into the marsh, namely, Marsh, Bog, Herm, and Dil. Two other stations were cut in and marked by 2 by 4 posts sunk into the marsh, namely, Flag and Isle. Cuts were taken from the different stations to the various natural objects in the vicinity, such as the tank at the Southern docks, dolphins in the river, and the stack at the picric acid plant.

A tide gauge was established at the Southern Railway docks, and also one at Crispen Island, and tidal observations were made at these points. There was no tide gauge at Brunswick, and so a gauge was established there, and simultaneous observations were made with the stations at the Southern docks and Crispen Island, so that a plane could be established from the bench marks at Brunswick.

Bench marks were established at Southern Railway docks and at Crispen Island, and were connected by levels to the tide staffs.

The topography of the Turtle River included the entire river from above the Southern docks to a point above Crispen Island.

J. S. Caruthers, inspector in local charge, United States Engineer Department at Brunswick, assisted in the work in every way possible, and loaned his launch to the party on several occasions.

Several buildings in Brunswick which have been located by previous triangulation were listed as useful aids to navigation.

The construction of a float pipe for an automatic tide gauge which was being built by the Brunswick Marine Construction Co. at Brunswick, Ga., was inspected. Specifications for the construction and installation of this pipe were furnished by the Washington office, and the work was afterwards completed according to the specifications.

On January 4, 1918, when the survey at Brunswick was completed, the chief of party proceeded to Fernandina, Fla., and installed this float pipe at the tide station there.

### FLORIDA.

[H. Leypoldt.]

Between January 1 and March 31, 1919, a resurvey was made of Key Biscayne Bay from its head to latitude 25° 35′, about the latitude of Fowey Rocks and Soldier Key, and the outside coast between the same northern and southern limits, extending just beyond the 10-fathom curve.

A tertiary scheme of triangulation had been executed during December, 1918, which gave good control of the work in the bay, and sufficient points, visible from the outside coast, were located, enabling the topographer to traverse between positions located topographically from prominent objects located by triangulation.

The coast and other land features are low and flat, wooded where not under cultivation, or else cleared for towns and townsites.

The topography was done on two 1:20,000 projections. A 1:10,000 sheet was completed. This sheet embraced the improved sections of this vicinity, namely, the city of Miami and the town of Miami Beach.

Extensive improvements in channels, buoyage, water front, viaducts, and towns necessitated a resurvey to keep the chart in proper relations to actual conditions. Large concrete water towers, conspicuous on the flat coast, were located so that mariners, in the steamer track through Florida Strait, could determine their position with accuracy when the new chart becomes available. A number of groundings by deep-draft vessels along this coast resulted in an 18-foot (position doubtful) sounding being placed on the chart. Unsuitable weather conditions prevented a thorough search for this feature, but the accomplished work is sufficient to show that the position given for this shoal is erroneous, due no doubt to the fact that no coastal features, either natural or artificial, were available for a better location except by estimating the distance from shore which, in hazy weather, is highly misleading.

Tidal stations were maintained at Miami, Cape Florida, Cutler, and Government Cut. It was impossible to establish a staff on Fowey Lighthouse, as a constant breaker washes the bottom of the structure. Soldier Key was also impracticable, as there was no one on the island to observe tides. The station at Miami was an automatic tide gauge; the other were staffs.

The old work was preliminary in character, and hydrography shown on the chart was insufficient for safe navigation.

The wind effect on the tides in Key Biscayne Bay is considerable, and a reference plane for sounding is unsatisfactory unless mariners are cautioned to make proper allowance for the variation of depths due to this cause.

[Chester A. Ober, Commanding Steamer *Hydrographer*.]

Summary of results.—Triangulation: 56.7 square miles of area covered, 31 signal poles erected, heights from 10 to 14 feet; 5 buoy signals with superstructures constructed, heights 12 to 14 feet; 4 observing tripods and scaffolds built, heights 64 and 48 feet; 3 stations in main scheme occupied for horizontal measures, 5 stations in supplemental schemes occupied for horizontal measures, 7 geographic positions determined. Leveling: 4 permanent bench marks established, 7.2 miles of levels run. Magnetic work: Ship swung at one sea station. Topography: 2.5 square miles of area surveyed, 14.3 miles of general coast line surveyed, 2 topographic sheets finished, scales 1:15,000. Hydrography: 72.2 square miles run while sounding, 6,833 positions determined (double angles), 48,251 soundings made, 2 tide stations established, 3 current stations occupied, 1 hydrographic sheet completed, scale 1:15,000.

On January 1, the *Hydrographer* was at Baltimore, Md., having completed the season's repairs, and made the necessary preparations for proceeding to Key West, Fla., to take up work requested by the Navy Department.

The vessel reached Key West safely on January 21. Consultations were had with naval officials; arrangements were made for obtaining coal, water, and certain supplies from the Navy; bids were put out, boilers cleaned, and on January 29, field work was begun.

Twenty-two hydrographic signals, from 10 to 14 feet high; five hydrographic signals (tripods), 20 feet high; four triangulation signals (tripods), 24 feet high; four scaffold signals, 48 and 64 feet high, were erected. Five water signals (buoys) were placed in position by the Lighthouse Service; on two bell buoys superstructures or cagings were built, 12 and 14 feet high.

Observations were made with a 6-inch Berger repeating theodolite. Two bases were used; one from Sand Key Lighthouse to Key West Lighthouse, the other from Sand Key Lighthouse to Vote (on Woman Key). There were necessarily a number of eccentric stations. It was intended that all measurements be remade, but as there was no opportunity for such work and as the differences in length found in the double determination of each distance came within the allowable maximum error, the observations were accepted as made.

Because the Navy had made several noticeable changes at Woman Key, the shore line and topographical features of this island were revised. Use was also made of the plane table to locate hydrographic signals. At Boca Grande Key, the small opening in the southwest side no longer exists. This was not noted until after the location of hydrographic signals had been accomplished, and when the command was transferred to G. C. Mattison, a memorandum was made of the need for revision of shore line at Boca Grande.

Three new tidal bench marks were established on the north part of the first island south of the large crescent-shaped key forming the northeastern half of the Marquesas group. These were connected by levels with the tide staff of 1919. One new bench mark was established at Sand Key Light, and all bench marks there connected by levels with the tide staff. At Key West the automatic tide gauge staff was connected by levels with the numerous bench marks in Key West and at Fort Taylor.

In the areas covered by the ship hydrography, 100-meter north and south lines were crossed by one-fourth-mile east and west lines, and shoal indications were developed. Sheet 2, which extends from Key West to Boca Grande, has all its ship work completed. A junction was made with sheet 3, which extends from Boca Grande to the western side of Marquesas, and work on sheet 3 was in a favorable state of progress at the date of the transfer of command. No splits or detached areas were left. Sheet 1, to the southward and eastward of Key West, was left untouched, as the Navy has no immediate use for work in that locality. Sheet 4, offshore sheet, 1: 40,000, has only the lines run in making the test of the new Coast and Geodetic Survey sounding tubes.

Work with launch *BBB*, and later with launch *Mandalay*, made favorable progress. On sheet 2 all except a very few areas were completed. One-hundred-meters north and south lines, crossed by one-fourth-mile east and west lines were also run by the launch. Through the keys to the westward of Key West, there is a small-boat channel, which was developed by the launch and used for running from Boca Grande Channel to Key West, whenever heavy seas prevented or endangered small-boat navigation north or south of the keys.

Three stations were occupied for current observations: Boca Grande Channel; Key West Harbor (just south of Frankfort Bank Beacon); and Man Key (about 1 mile south of the southern and eastern end of Man Key). Complete data were entered in the record book for current observations.

The automatic gauge at Key West was placed in satisfactory running condition, and frequent inspections made, to insure an unbroken series of readings. A new staff was furnished for this station, and samples of the old staffs were forwarded to the office. A report on this station was made early in April.

Computations, description of stations, work on sheets and records, reports, and accounts, take up no inconsiderable portion of the *Hydrographer's* time in the field, and voluntary overtime and night work on the part of the chief of party, officers, and crew deserve especial mention.

Several minor repair items were accomplished during the working season, with little or no delay to the work in the field. The first officer and chief engineer deserve a good deal of credit for the efficient upkeep of their respective departments.

Whenever possible, the *Hydrographer* left Key West Monday morning, remained on the working grounds during the week, and returned to Key West at the end of the week for water, coal, and supplies. For work on sheet 3, water signals were used. These floating signals were located each day; it is believed, however, that an ebb or flood tide position, or certain wind and sea positions, may be determined. High scaffold signals were used, in order that control might be had out to the 100-fathom curve. A few small hydrographic signals, used for launch work inside the reefs, were located by sextant angles. Plane table location could have been made only after a great deal of work and loss in time, because the mangroves overhang the shore, and a depth of 3 to 5 feet of water is found close to the mangroves.

Close cooperation was maintained with the Navy and with the Lighthouse Service. The latter placed five buoys to be used as floating signals, and also granted permission for the placing of cross targets on several of the beacons in the vicinity of Key West.

### [G. C. MATTISON, Commanding Steamer *Hydrographer*.]

**SUMMARY OF RESULTS.—Triangulation: 1 scaffold built, height 63 feet. Topography: 2.3 miles of shore line of rivers surveyed. Hydrography: 45.6 square miles of area covered, 590.4 miles run while sounding, 3,192 positions determined (double angles), 20,072 soundings made, 1 current station occupied; scale of hydrographic sheets 1: 15,000 and 1: 40,000.**

On June 4, the command of the *Hydrographer* was transferred from Chester H. Ober to G. C. Mattison. The vessel immediately proceeded to Marquesas Keys, and rebuilt triangulation station South, a 63-foot scaffold, which had previously blown down. Three days were spent in rebuilding this signal, and as it required the whole available deck force, the ship occupied a current station latitude 24° 30′, longitude 82° 04′ 45″ for a period of 52 hours, the launch being used to transport the working party to and from the ship.

Practically the whole of the remainder of the month was spent in doing hydrographic work.

Hydrographic signals on Marquesas were relocated by plane table. A previous traverse had been run, but the traverse did not close on stations formerly located by the party under Assistant Hodgkins. The error was found, however, and the signals are now properly located. This work was done on hydrographic boat sheet No. 3, it not being considered necessary to make a topographic sheet for this short traverse.

The only sounding done by the ship was on sheet No. 3. No indications of new shoals were found, nor were any shoals developed. A few offshore lines were run on sheet 4, south of Coalbin Rock. The new Coast and Geodetic

Survey sounding tubes were used, but a weakness was found to develop after several days' use in that the collar which holds the pivoted clamp works loose, owing to the great pressure; otherwise these tubes are apparently satisfactory.

The areas in the vicinity of Boca Grande, Man, or Woman Keys were completed by the launch. However, there remain a few shoal indications to be developed. It was necessary for the launch to do this work, as unfavorable weather conditions made it impossible to work in more exposed waters. A little sounding was done by the launch south and west of Marquesas on sheet 3.

Tide observations were made at Sand Key Lighthouse during this period by the lighthouse keepers. Marquesas tidal station was occupied for a period of 50 hours. This was done during a period of bad weather, and the launch was anchored at the tide station with three men using it as quarters. During this time it would have been practically impossible for the launch to do any sounding. Tides were read during the day at Marquesas for work on sheet 3, a seaman from the *Hydrographer* being used for that purpose. Automatic tide gauge at Key West was in operation during this period. A new tide staff was installed at Sand Key to replace the old one in use there.

Orders were received on June 12 to cooperate with the naval air service in experimental work to ascertain whether or not it is feasible so to photograph the coral heads that areas so photographed will not have to be wire dragged. The naval air station at Key West did not receive instructions until June 27. The first work done was on June 30. A series of 24 photographs were taken, and it was the intention to take more, but the plane had developed engine trouble, and found it necessary to return to Key West.

The results were not very good on this day owing to the high range of tide, the current running in and out of the channel near Key West keeping the water in clouded condition. A great many of the charted shoals did not show at all on the photographs. These photographs were taken at elevations varying from 2,300 to 4,300 feet. A high-power camera was used, and those shoals which did show on the photographs were as clear at an elevation of 4,300 as at 2,300 feet.

### [E. E. REESE.]

SUMMARY OF RESULTS.—Signal building: 8 main points selected for erection of signals, 1 hydrographic signal built, height 103 feet.

On June 2 instructions were given for the erection of signal towers for offshore hydrography on the Gulf coast from a short distance east of Pensacola, Fla., to Mobile Bay. From June 2 to 8 the time was spent at the Washington, D. C., office preparing for field work, including ordering wire at Washington, and sending out proposals for hire of launch. June 9 and 10 were spent en route to Pensacola, Fla.

Field work began June 11, and the period June 11 to 22 was spent in getting outfit together, organizing party, and hiring launch. Much difficulty was encountered in getting a launch.

Actual signal building began June 23, and one tower was completed by the end of the month. This is 103 feet above ground, and 120 feet above sea level. This is the second tower from the east end of the work. In order to save time, the signal farthest east was left until after the larger and faster launch was available.

## LOUISIANA.

### [J. B. BOUTELLE.]

During the fiscal year an officer has continued on duty at New Orleans as inspector for the Gulf of Mexico, during the greater part of the time engaged in the usual work of the office, attending to official correspondence, distribution and sale of charts and publications, supplying information in reply to requests from officials and from the public, and collecting information required for the correction of the charts.

From September 7 to 9 the inspector was at Pascagoula, Miss., engaged in revising the topography of that harbor.

In August the board of commissioners of the Public Belt Railway of New Orleans requested data and instruments in order to make surveys on the Mississippi River to show the practicability of building a bridge over or a tunnel under the Mississippi River at that place.

Information was furnished, and the necessary instruments were loaned to the engineer of the commission, and the inspector aided him when he was unable to obtain other expert assistance.

Blue prints, maps, and information for the correction of charts, obtained from the United States Engineers, and from other sources, were forwarded by the inspector to the Washington office.

Charts, publications, and information relating to surveys were furnished in reply to numerous requests from officials or others.

A stock of charts, and nautical publications was kept on hand for reference.

In January, and again in June, topographic information in reference to harbor improvements was collected at Mobile, Ala., and current apparatus was installed on Heald Bank lightship. In February repairs to the tide gauge at Fort Morgan, Ala., were supervised, and an inspection trip was taken with the superintendent of lighthouses from Morgan City to New Orleans, by way of the Gulf of Mexico and inland routes.

[F. H. HARDY, Commanding Steamer *Surveyor*.]

SUMMARY OF RESULTS.—Hydrography: 62 deep-sea soundings made, 29 observations of bottom temperatures made, 43 observations of surface temperatures made, 57 bottom specimens preserved.

The steamer *Surveyor* left Norfolk, Va., April 21, 1919, under instructions to proceed to the Pacific coast by way of the Panama Canal. Deep-sea soundings were made during the voyage, beginning on April 22, from latitude 34° 00′, longitude 71° 40′ to San Salvador, and across the Caribbean Sea, and thence to a point off the coast of Lower California, the last sounding being taken on May 18.

[R. R. LUKENS, Commanding Steamer *Wenonah*.]

SUMMARY OF RESULTS.—Hydrography: 39 deep-sea soundings made.

The steamer *Wenonah* left New York for the Pacific coast by way of the Panama Canal on May 22, stopping at Norfolk, Va., to install a deep-sea sounding machine, and also stopping at Kingston, Jamaica, for coal and supplies.

Deep-sea soundings were begun off Cape Hatteras, and 37 soundings were made between Cape Hatteras and Colon where the vessel arrived June 26.

The vessel left Kingston, Jamaica, at 7 a. m., June 21, and proceeded to take up the sounding line to Colon.

Just outside of Kingston Harbor, a very heavy southeasterly sea was encountered, accompanied by a fresh breeze from the same direction. Although it was very rough, three soundings were attempted without success, due to the excessive pitching and rolling, and it was considered that to continue operations would only mean a loss of material, which was already running short.

Accordingly sounding was discontinued, and the vessel proceeded on her course, making very bad weather of it rolling 30 to 42 degrees, with the alleyways filled with water. Neither officers nor men could sleep below, and there was spray over the decks constantly, making sleep there impossible.

At daylight, June 23, the wind moderated enough so that two soundings, one of 1,700 and the other of 1,900 fathoms were made. The ship passed through the breakwater at 10.30 p. m., June 23, and anchored in Colon Harbor.

## HYDROGRAPHIC AND TOPOGRAPHIC WORK, PACIFIC COAST.

### CALIFORNIA.

[ARTHUR JOACHIMS.]

SUMMARY OF RESULTS.—Hydrography (wire drag): 23 square miles of area dragged, 69.2 miles run while dragging, 298 positions determined (double angles), 1,129 soundings made, 2.3 square miles of area sounded, 25.5 miles run while sounding, 4 hydrographic sheets finished, scale 1:12,000.

Between May 5 and June 3, 1919, a wire-drag survey was made around the entire shore of Lake Tahoe to discover dangers to navigation. The survey was made at the request of and in accordance with the requirements of the United States Reclamation Service.

It was only after a careful study was made of the hydrographic sheets by the Reclamation Service and of the lake itself, that a definite conclusion could be reached as to the logical effective depth to drag. This matter was discussed with the project manager of the Reclamation Service at Fallon, Nev., who emphasized the importance of dragging in close to shore, as it was here only that obstructions could be expected, since with few exceptions deep water could be found within 500 yards of the shore. A definite conclusion was reached by the assistant engineer, United States Reclamation Service, assigned to cooperate in the wire-drag work, and the chief of the drag, that they could drag completely around the shore of the lake carrying an effective depth of 16 to 17 feet for the present height of the lake, which, if corrected to a datum of 6,223, would be about 12 feet effective depth. For the purpose of getting in close to shore it was agreed that they should hook up the two inshore buoys to 12½ and 13 feet.

The hydrographic sheets of the Reclamation Service show two-thirds of the shore of Lake Tahoe to be rather bold and dropping off into deep water, and the other one-third consisting of shoal shelves covered in most cases with large bowlders, and in a few instances, clear sand. These shelves run out from 200 to 500 yards, except in two or three instances where they extend out about three-fourths of a mile. At their outer edge they drop boldly into deep water. Considering the type of navigation to ply on the lake, namely, boats drawing from 3 to 7½ feet, it was important to drag these shoal shelves, over which it was in general only practicable to carry 16 to 17 feet. Also, the time allotted for the work was so limited that attention was given only to the most important parts. From the outer limits of these shoals extends blue water which, owing to the clearness of the lake, signifies that it is quite deep. It was requested that all the time be spent on work over the shoal areas, as the whole purpose of the survey was to locate any obstructions to navigation which had been missed on these shoals by the previous hydrographic survey of the Reclamation Service.

A drag strip of from 1,700 to 1,900 feet was run with an effort to keep as closely inshore as possible. A number of shoals, in most cases bowlders, were located with one-half foot to 7 feet of water over them.

There were four sheets covering the work of this survey, which include the complete area of the lake. They were made on a scale of 1 inch to 1,000 feet, which was requested by the Reclamation Service. The soundings taken on drag shoals were plotted in ink.

Sheet No. 1 begins at Sugar Pine Point, on the California coast, and extends to Tahoe Vista, which is about 1 mile west of State Line Point.

Sheet No. 2 starts where No. 1 ends and extends around the Nevada shore to a point about three-fourths mile south of Glenbrook. A drag strip of 1.700 to 1,800 feet was run completely around the shore line and inshore as close as it was possible to drag. The two important points on this sheet by way of shoal are at State Line Point and off the point marking the southern limits of San Harbor.

Sheet No. 3 continues from sheet No. 2 and extends to a point 1.5 miles west of Tallac.

Sheet No. 4 continues from sheet No. 3 and overlaps on sheet No. 1, making a closure of the drag survey around the lake.

Bowlders off State Line Point are exceedingly dangerous, as it is natural for vessels to stand in close to this point when enroute from Crystal Bay to the city of Tahoe. They are also deceiving in that blue water can be found only a few yards out board from them.

The bowlder shoal off the southern point of Sand Harbor, the one just south of Glenbrook, and also off Zephyr Cove, since they offer no warning to vessels, deep water surrounding them, are dangerous.

The entrance to Emerald Bay is bordered on both sides by bowlder reefs that on the north side extend about half way across the entrance and contain very dangerous bowlders. The south side does not extend very far out from shore, however, it also is very foul with bowlders. So the channel is only 85 yards in the narrowest place and has a sand bottom. It is a level bottom with an average depth of about 8 feet at 6,223 elevation of the lake. Emerald Bay was dragged, and no dangers discovered after passing the entrance.

Off the city of Tahoe a number of dangerous bowlders were discovered, which are of importance in that this place at present is most frequented by vessels.

A number of minor shoals were discovered a knowledge of which is important to vessels skirting the shores of the lake.

If the elevation of the lake was lowered to 6,223, the results of this survey would show definitely the conditions of the areas bordering the shore, since the survey was made on that datum. So far as the bowlders are concerned, it would in most cases be a benefit, since a number of them would be awash and could be seen more readily. It is true, however, that the shoals off the cities of Tahoe and Bijou, having less water, would make docking at these places difficult for vessels drawing over 7 feet. The docks, on the other hand, could be lengthened, and in that way meet the requirements. The important factor is not so much the elevation as is the range. A large range would vary conditions so that those navigating the lake would have to build their docks to meet the conditions of extreme low water, and at the same time they would always be subjected to figuring out the depths carried at various elevations of the lake. Any misunderstanding in this regard might lead to disaster.

Previous years of observations have shown that the lake never has reached an elevation lower than 6,223. In 1864 it reached the lowest of any known record which was 6,223.5. In 1862 it attained its maximum elevation of 6,231. That shows a natural range of 7.5 feet. For vessels drawing only 2 to 7.5 feet, which is the case with all vessels to consider on the lake, this range is of vital importance. The tendency would be to err in allowing for the height above the datum. To minimize the range and make it as near a constant as possible would be an aid to navigation. The ideal condition would be to keep the lake at a constant elevation. That condition is impracticable owing to the rapid rising of the lake during the early summer months when the snow begins to melt; also, during the year there is an annual evaporation of from 30 to 36 inches. These to a certain extent compensate, and there is no doubt that the elevation of the lake can be held more nearly a constant than its natural range would allow, by regulating the overflow at the Truckee River.

The commercial navigational interests of the lake are at the present time almost solely centered in the Bliss Transportation Co. which has one steamer and two launches plying on the lake. The steamer is the *Tahoe*, which is 172 feet long, and draws 6 feet. The launches are the *Meteor*, drawing 7 feet, and the *Nevada*, drawing 6 feet.

The *Tahoe* makes one trip a day around the lake during the summer, and one of the other two launches makes a round trip twice a week during the rest of the year.

The remainder of the navigation on the lake is that of pleasure launches owned by property owners, and run for their own use. These launches are, in the majority, boats which draw about 3 or 4 feet, and are from 25 to 50 feet in length.

Previously there had been a small amount of lightering on the lake when the Carson Tahoe Lumber & Fluming Co. was engaged at logging on the Nevada shore. This company has not operated for several years past.

True to the general understanding, Lake Tahoe is used almost solely as a summer resort. The people who make their homes here carry on industries which maintain the place as such. The total number of people remaining at the lake during the winter of 1918–19 was about 40, while it is estimated that about 6,000 are here during the middle of the summer season.

Along the California coast of the lake it is estimated there are at least 150 large summer homes, owned in the most part by wealthy people who spend their summer vacation at the lake. In addition to these homes there are 16 hotels, which accommodate from 50 to 500 guests each.

Along the Nevada shore there are few resorts, Incline and Glenbrook being practically all the settlements. These two places were originally started when the Lake Tahoe Lumber & Fluming Co. was operating on the lake.

The topographic features of the shores of the lake are of two classes. On the California shore there is a tendency to even mountain slopes leading down to the lake, while on the Nevada side the irregular granite mountain slopes quite frequently are steep and rugged. The lake appears to be locked in by mountains ranging from 1,500 to 5,000 feet above the level of the lake. There are, however, a number of draws through the mountains to the lake, the principal one of these being between Truckee and Tahoe, where the Truckee River flows.

These high mountains furnish large watersheds for Lake Tahoe, and during the early summer the water from melting snow feeds the lake by eight fairly large mountain streams. Truckee River, on the other hand, is the only outlet.

[E. B. LATHAM.]

SUMMARY OF RESULTS.—Reconnoissance: Length of scheme 8 miles, 18 square miles of area covered, 12 points selected for scheme. Triangulation: 20 square miles of area covered, 15 signal poles erected, 12 stations in main scheme occupied for horizontal measures, 19 geographic positions determined. Leveling: 25 miles of levels run. Topography: 10.5 square miles of area surveyed, 80 miles of detailed shore line surveyed, 7 miles of roads surveyed, 1 topographic sheet finished, scale 1:10,000. Hydrography: 4 square miles of area surveyed, 136 miles run while sounding, 1,389 positions determined (double angles), 8,856 soundings made, 2 tidal stations established, 2 current stations occupied, 1 hydrographic sheet finished, scale 1:5,000.

Between January 24 and April 2 a resurvey was made of Morro Bay, Calif., including topography and hydrography and the triangulation necessary for control.

Triangulation stations—White 1881, Black Hill 1881 and 83, and Cass 1883 and 1916—were recovered, the necessary signals erected, and the observations for the triangulation made between February 5 and 17.

Preparation was made to take advantage of favorable conditions for obtaining soundings in the entrance to the bay, but there were only two days on which it was possible to venture on the bar between February 12 and April 2. On these two days the necessary soundings outside the bay and on the bar were obtained.

The soundings taken indicate the width and depths in the approach to the bay on the south side of Morro Rock, and the width and depths to a limited extent on the north side of the rock. There is no practicable entrance on the north side of Morro Rock.

A large part of the area of the bay was covered by leveling instead of sounding from a boat. It was impracticable to pass over the higher flats in a boat.

At the southern end of the bay there is some area that is not covered by soundings. It was impracticable to pass over this area in a boat, and the mud flats are too soft to walk on.

The weather conditions are most unfavorable at this time of the year for surveying operations at Morro. Only one boat ventured outside the bay between January 24 and April 3. It was reported that she narrowly escaped swamping on her return.

An automatic tide station was operated at Morro during the progress of the work. A tide staff was read near the head of the bay when sounding operations were in progress, and a 48-hour series of readings were observed while the current observations were being made.

Two current stations were occupied for a series of 25 hours each.

[E. B. LATHAM.]

SUMMARY OF RESULTS.—Reconnoissance: Length of scheme 72 miles, 242 square miles of area covered, 45 points selected for scheme. Triangulation: 242 square miles of area covered, 35 signals erected, 25 stations in main scheme occupied for horizontal measures, 110 geographic positions determined.

After collecting data at San Francisco and making necessary arrangements, parties were organized at Eureka, Calif., in the early part of April, 1919, to search for old triangulation stations, and erect signals for use in offshore hydrography from Punta Gorda to the mouth of the Klamath River.

At the close of the fiscal year this work was approaching completion.

[F. WESTDAHL.]

SUMMARY OF RESULTS.—Hydrography: 0.5 square mile of area covered, 12.6 miles run while sounding, 894 positions determined (double angles). 761 soundings made, 1 hydrographic sheet finished, scale 1 : 5,000.

In July, 1918, instructions were issued for a resurvey of the Presidio Shoal, San Francisco Bay.

The field work was done between August 13 and 30, working only when the tide and wind were favorable.

The soundings were reduced and plotted, and the original sheet was forwarded to the Washington office on September 17.

A boat and crew were furnished by the Presidio Life Saving Station, and the assistant supervisor of the twelfth naval district detailed two officers of the naval reserve to assist in the work.

The resurvey indicates that the shoal has shifted its position by about its own width to the southward. It also indicates that the shoal has no rocky basis, being in fact formed by the meeting of the ebb currents from the northern and southern arms of San Francisco Bay, and the consequent release of the material carried in suspension by these currents. The greater amount of suspended material is carried from the northern arm of the bay, and where this current is reinforced by the volume rushing through Raccoon Strait and meeting the current from the southern arm, the greatest amount of material is dropped, forming the Presidio Shoal.

The shoalest water, 21 feet, was found in two places about 130 meters apart.

[E. F. DICKINS.]

An officer of the Survey has continued to serve as inspector of the Bureau for the coast of California, and in charge of the field station at San Francisco, Calif.

The chief duty of this officer is the inspection of the navigable waters within his district, the collection of information necessary for the correction of the charts, coast pilots, and tide tables, and to furnish to the public information relating to the coasts of the United States.

Under the supervision of the inspector an automatic tide gauge was maintained throughout the year at the Presidio station, San Francisco, by means of which a continuous record of the time and height of the tide was obtained.

The field station has kept on hand a stock of charts and nautical publications for sale and reference; obtained information required for the correction of the charts and coast pilots; furnished information and charts to Government officials and others on application; supplied tidal information and advance notices affecting navigation for publication in the newspapers; attended to forwarding instruments and supplies to the field station of the Survey at Manila, P. I., and furnished transportation to officers of the Survey upon request.

A revisionary survey for the correction of charts was made in the vicinity of San Pedro, Calif., and an inspection was made of changes and corrections at Port Richmond and Ellis Creek to obtain information for the same purpose.

### WASHINGTON.

[JOHN W. MAUPIN.]

SUMMARY OF RESULTS.—Reconnoissance: 5 square miles of area covered, 56 lines of intervisibility determined, 4 points selected for scheme. Triangulation: 14 square miles of area covered, 13 signal poles erected, 6 stations occupied for horizontal measures, 18 geographic positions determined. Leveling: 2 bench marks established. Topography: 8.4 square miles of area surveyed, 27.6 miles of general coast line surveyed, 11.8 miles of creeks surveyed, 11.3 miles of roads surveyed, 1 topographic sheet finished, scale 1:5,000. Hydrography: 1.7 square miles of area covered, 7,817 miles run while sounding, 998 positions determined (double angles), 3,063 soundings made, 1 tide station established, 1 hydrographic sheet finished, scale 1:5,000.

In compliance with instructions dated November 5, 1918, a party was organized for a revision of the chart of Commencement Bay, Tacoma Harbor, Wash., and the actual field work was begun on December 23, 1918.

The Tacoma city engineers were interviewed and a thorough reconnoissance was made of the entire water front before laying out the work which was considered necessary. One week was spent in signal building and searching for the old triangulation station before the triangulation observations were started. The weather proved so thick and adverse for triangulation that it was decided to locate sufficient points for beginning the plane-table work, and to complete the triangulation observations at a later date when weather conditions should improve.

With a few exceptions the methods employed were the usual Coast Survey procedure. Although the instructions called for chart revision work, so many changes were found in the Tacoma water front it was found necessary to make a resurvey of the water front, waterways, etc. Upon the advice of the inspector at Seattle, and with a view to future chart corrections, it was decided to do the hydrographic and topographic work on a scale of 1:5,000. All prominent objects which were considered essential to the construction of a new chart were located by triangulation. Two blue prints were obtained, showing all railroad tracks and other topographic features, and enough points were located on these prints for transferring to the chart. At several places the waterways were choked with logs, and it was found necessary to walk over the log rafts, taking many detached soundings, which proved to be slow and tedious work. A photostat copy of the previous work on a scale of 1:10,000 was used as a revision sheet for the topography outside the limits of the topographic sheet on which the present work was done. All the topographic features along the water front falling within the limits of chart No. 6451, were corrected on this sheet, and the hydrography was tested at a number of different places, but no changes could be found. With the exception of taking left angle, practically all the instrument work was done by the chief of party.

The tide flats at Tacoma are surrounded by highlands in most directions. It is due to this fact that the smoke from the many factory chimneys settles down over the tidelands, making the atmosphere extremely thick and unfavorable for field instrument work. For the same reason the wind does not readily carry the fog away. In general the weather conditions were extremely adverse, and field work could be accomplished only on an average of about one-third of the working time. Southerly storms, lasting several days at a time, often accompanied by hail or snow, were frequent. The weather conditions improved to some extent during the last two weeks of the season.

The work was done in close and accurate detail, and is believed to be entirely sufficient for the construction of a new chart. A number of triangulation stations were substantially marked for use in the future revision work. The season's work was closed on March 31, and in accordance with instructions, the chief of party was ready to take over the steamers *Patterson* and *Explorer* on April 1 in compliance with the executive order for the retransfer of these from the Navy.

From April 1 to June 30, 1919, the chief of party was in command of the steamers *Explorer* and *Patterson*.

An inspection was made of one of the chart agencies of the Survey at Seattle, and various duties were performed relating to the transfer and shipping of property, caring for wire-drag launches and property, and preparation of inventories.

## GEODETIC WORK.

### UTAH.

[GEORGE D. COWIE.]

SUMMARY OF RESULTS.—Reconnoissance: 11 stations selected for primary triangulation. Triangulation: 11 observation stands erected for primary work, 80 stands erected for supplementary stations, 2 stations occupied for observations.

In May, 1919, work was begun on the extension of primary and secondary triangulation in Utah over an area indicated by the Forest Service.

On May 7 the observer arrived in Ogden, and after conference with the Forest Service officials there, made final preparations for field work at Richfield, Utah.

About May 17 reconnoissance for primary triangulation was begun, and by June 9 eleven stations were established, and observation stands were erected. During this time several parties comprised of men from the Forest Service, running expenses paid by the Coast and Geodetic Survey, were in the field, erecting supplementary stations to give immediate control over the Fish Lake, Dillmore, and Manti Forest Reserves.

These parties set up about one pole, with banners, per day while in the field. In all nearly 80 supplementary stations were erected.

On June 17 the observing party and light keepers left Richfield for their various stations, and on the 19th observations were begun at the old 1882 Tusher triangulation station of the United States transcontinental line. This station was completed and observations half completed at Station Monroe by June 30.

One United States motor truck and one rented car were used in addition to horses.

### ARIZONA.

[C. V. HODGSON.]

SUMMARY OF RESULTS.—Reconnoissance: 8 points selected for scheme. Triangulation: 16 observing tripods built (all stands except one 12-foot signal), 1 observing scaffold built, height 12 feet, 2 stations in main scheme occupied for horizontal measures, 2 stations occupied for vertical measures, 1 elevation determined trigonometrically.

On April 11 Mr. Hodgson left the office to take up the work called for in the instructions of the superintendent, dated April 7, 1919, which provided first for a reconnoissance for control stations over portions of the Arizona national forests for the benefit of the Forest Service topographers, and later for an extension of primary triangulation from the Texas-California arc over the areas to be controlled, and thence eastward along the El Reno-Needles arc, the reconnoissance for which was done in 1916.

On the way out a stop was made at Albuquerque to consult with the district forester and with the topographer in charge of the work. A reconnoissance trip in conjunction with Mr. Daves, the topographer, was arranged for, and a small amount of outfit obtained from the district office.

The time from April 21, on which date the chief of party arrived at Prescott, until the early part of June was taken up in the preliminary reconnoissance, in making arrangements for the building party under the charge of Signalman Lutz to take the field, and in securing light keepers.

Six of the eight light keepers were finally secured by June 2, and since they had been leaving as rapidly as they could be secured, the chief of party decided to leave with only a couple of days training of the new arrivals. The light keepers left for their stations on June 4, and the observing party started to the first station at Harquahalla. From that time to the end of the month the work was actively prosecuted.

### TEXAS AND LOUISIANA.

[J. S. BILBY.]

SUMMARY OF RESULTS.—Reconnoissance: Length of scheme 245 miles, 3,520 square miles of area covered, 53 points selected for scheme. Base lines primary (selected) Jacksonville, length 4½ miles. Traverse (reconnoissance), length 185 miles. Triangulation: 48 observing tripods built, total height 2,198 feet, 48 observing scaffolds built, total height 2,797 feet.

In October, 1918, a party was organized for the purpose of making a reconnoissance from the ninety-eighth meridian triangulation in the vicinity of Waco, Tex., eastward to the Mississippi River. This work had been requested by the Chief of Engineers, United States Army, to furnish data to be used in military mapping.

The chief of party arrived at Waco, Tex., October 24, and began the preliminary work of collecting and repairing the automobile trucks to be used in transporting the party.

The work of selecting stations for the primary triangulation was then taken up, and by January 3 the reconnoissance had been completed, and stations selected from points in the ninety-eighth meridian triangulation eastward to the vicinity of Jacksonville, Tex., and a preliminary reconnoissance had been made for the purpose of selecting the best route for triangulation from Jacksonville eastward to Robeline, La.

On account of the heavy rains and bad condition of roads, it was not practicable to continue the reconnoissance to the river at that time. On January 3, the chief of party returned to Waco, Tex., to organize a building party, and start building signals.

At Waco the outfit and trucks were overhauled, a party organized, and on February 1 the party and outfit were ready for the field. Building signals and preparing the stations were extended from the ninety-eighth meridian triangulation stations eastward, and by April 12 the building was completed to the vicinity of Jacksonville. From Jacksonville east the stations were selected during the process of building. Heavy continuous rains kept the roads in bad condition, and added considerably to the difficulties of the work.

Stations were selected and signals built for primary triangulation to Mansfield, La. It was not practicable to extend triangulation to the eastward of Mansfield, on account of the high timber, flat low country, bad roads, and unfavorable conditions. A reconnoissance was made for primary traverse from Mansfield to the Mississippi River at Vidalia. Stations were selected and signals built for primary traverse from Station Field to the Texas & Pacific Railroad.

During the progress of work, descriptions of stations, and progress sketches were furnished the chief of the observing party, and to the office.

By June 30 the actual field work of reconnoissance and building had been completed for the triangulation, and the party was preparing to move to Oklahoma, and take up work in the execution of instructions dated June 23, 1919.

The total length of the scheme for primary triangulation from the ninety-eighth meridian triangulation to Mansfield, La., is 245 miles. There are 44 stations in the main scheme, 2 LaPlace stations, and 1 base line. Three primary traverse stations were selected at which signals were built, and the stations marked to make the connection from a station of the triangulation to a station on the Texas & Pacific Railway track at Mansfield. This traverse connection was made by staking about 450 meters from Station Field to a station on the Kansas City Southern Railway, then along the Kansas City Southern Railway track northward to the Texas & Pacific Railway, crossing at South Mansfield, a distance of about 1½ miles.

The total length of the scheme selected for primary traverse from Mansfield to Vidalia is about 185 miles. The route selected is from Mansfield to Alexandria, on the Texas & Pacific Railroad, Alexandria to Georgetown, Georgetown to Vidalia, on the St. Louis, Iron Mountain & Southern Railway.

### DELAWARE.

[Gardiner Luce.]

**Summary of results.**—Triangulation: 10 square miles of area covered, 18 triangulation stations visited or recovered, 7 stations occupied for horizontal angles, 4 geographic positions determined. Signal building: 2 tall hydrographic signals built.

On May 9 instructions were given for the organization of a party and the erection of tall hydrographic signals on the coast of Delaware for the use of the steamer *Isis*, and later instructions were given for the location of prominent land marks. Supplemental instructions were afterwards issued for the running of a traverse, for the recovery of old triangulation stations, and the location of new stations, if necessary, within the requirements of tertiary triangulation.

On June 23 instructions were issued at the request of the Navy Department, for determining the positions of the Navy radio compass stations at Bethany Beach, Cape Henlopen, and Cape May, and then to close work.

On May 12 headquarters were established at Lewes, Del., and bids for supplies obtained in Lewes and Wilmington, Del. The necessary hands were hired.

From May 12 to May 22 the chief of party was occupied at Lewes, Del., in reconnoissance, triangulation, obtaining supplies, and organizing party.

On May 23 the party was moved to Ocean View, Del., where a tall type of hydrographic signal was constructed over the triangulation station on Cotton Patch Hill, reaching to a height of 115 feet above high water. This signal was erected on a sand hill 40 feet in elevation.

The signal was completed on May 30 and the party returned to Lewes, Del.

On June 2, 1919, the lumber, wire, and signal-building outfit were hauled to triangulation station, Midway, 2½ miles south of Rehoboth, on the narrow strip of land between Rehoboth Bay and the ocean. The next day construction of a tall-type signal was commenced over this station by the chief of party and four men, and completed to a height of 120 feet above high water on June 13, two and one-half days being lost by bad weather.

From June 14 to June 30, inclusive, the chief of party was occupied on triangulation, locating all prominent objects useful to navigation and the survey work of the steamer *Isis*.

### NORTH CAROLINA.

[C. L. Garner and Max Steinberg.]

**Summary of results.**—Reconnoissance: Length of scheme 120 miles. 1,260 square miles of area covered, 37 lines of intervisibility determined, 17 points selected for scheme. Triangulation (primary): 1,260 square miles of area covered, 27 observing scaffolds and tripods built (heights 4 to 80 feet), 16 stations in main scheme occupied for horizontal measures, 16 stations occupied for vertical measures, 30 geographic positions determined, 25 elevations determined trigonometrically. Leveling: 30 permanent bench marks established, 50 miles of levels run. Azimuth: 1 station occupied for observation of azimuth.

On September 28, 1918, instructions were issued to Mr. Garner to carry a scheme of primary triangulation or primary traverse from the eastern oblique arc triangulation in the vicinity of Madison to the Norfolk-Savannah line of primary traverse in the vicinity of Sanford, N. C. The instructions also called for a line of precise levels which should extend from the vicinity of Greensboro to Sanford, N. C.

Reconnoissance for this work began about October 15, and was finished about November 18. It was decided that it was best to have triangulation from the oblique arc to Sanford. The observations for the work began shortly after November 1. Considerable difficulty was encountered in getting off the large figures of the old triangulation to connect with the new work on account of haze.

That part of the scheme of triangulation which makes a connection with the primary traverse which extends from Savannah, Ga., to Norfolk, Va., was done by the party of Max Steinberg. This connection was made, and the two parties completed the work at the end of December, 1918.

### GEORGIA.

[O. W. Ferguson.]

**Summary of results.**—Primary traverse: Length of traverse check-measured 550 miles (measured once) and 67 miles (measured more than once). 20 stations occupied for check horizontal measures. Azimuth: Stations occupied for approximate azimuth.

The revision of the primary traverse on the line from Macon to Griffin, Ga., was begun August 16 at Macon, Ga., where an azimuth was measured on the night of August 30.

Azimuth was observed at numerous points between stations Southern and Forsyth, and all lines were remeasured and errors located. This section was finished October 2.

Between October 3 and 8, all measurements in and near Macon were checked, and several stations were occupied for horizontal angles, in order to detect and correct errors.

On the completion of this work check measurements were made on the lines from Macon to Columbus, and Macon to Brunswick.

The checking of the measurements on the line from Macon to Columbus was begun October 9, and completed November 10. The remeasurement of the line from Macon to Brunswick was begun November 10, and completed December 14.

The measurement of the line from Macon to Savannah was next taken up, and the line was completed and field work closed on February 16, 1919.

On February 17 an investigation was made of the traverse base at Dublin, and on February 26 the observer reported at the Washington office.

### [E. D. BROMLEY.]

On June 2, 1919, instructions were received to remeasure the angles on the primary traverse line, Macon to Forsyth, Ga.

Up to June 30, 1919, 45 of these stations had been recovered, 39 signal tripods built, and 16 had been occupied and the angles remeasured with a 12-inch direction instrument, using eight positions at each station.

In remeasuring these angles, tripod signals were built to give clearance above the track and ground of not less than 6 feet, and in most cases the line of sight was 15 to 20 feet above the ground. The tripods were built rigid, and great care was exercised in the centering of the signal pins and the instrument over the station mark.

An auto truck was used for transportation along the public highway, which is in most cases near the Central of Georgia Railway tracks. This, probably, was the cheapest means of transportation for this particular piece of work, as the employment of conductors when motor cars are used is very expensive.

While the hire of the truck was a little greater than ordinary, owing to the unusual demand, the truck proved very efficient. In case there was much rain, the Georgia red-clay roads would be almost impassable with a truck.

## TEXAS AND LOUISIANA.

### [C. L. GARNER.]

SUMMARY OF RESULTS.—Triangulation: 3,400 square miles of area covered, 38 stations in main scheme occupied for horizontal measures, 38 stations occupied for vertical measures, 126 geographical positions determined, 126 elevations determined trigonometrically. Azimuth: 4 stations occupied for observations of azimuth (including 2 La Place stations).

On February 27, 1919, instructions were issued to Mr. Garner to begin observations for a scheme of primary triangulation and primary traverse extending from the ninety-eighth meridian in the vicinity of Waco, Tex., eastward to the Mississippi River. The reconnoissance for this work had been completed as far as Mansfield, La., by the end of December, 1918. The signal building was started shortly after January 1, 1919. The work was requested by the Chief of Engineers, U. S. Army.

Mr. Garner arrived at Waco, Tex., on March 24, 1919, and began organizing his party for the work and overhauling the trucks which were to be used on the work. These trucks were used in hauling the outfit and light keepers to the various triangulation stations. The actual observing started on April 15. By the end of the fiscal year the work had been completed nearly to Mansfield, La. There remained only seven stations to be occupied.

There were a number of high towers in the scheme of triangulation, and at times the wind made them unsteady. Nevertheless, the closures of the triangles averaged only about one second. The work was made difficult at times by heavy rains.

Electric signal lights with dry-cell batteries were used throughout the season and proved most satisfactory.

### NORTH CAROLINA AND SOUTH CAROLINA.

[MAX STEINBERG.]

SUMMARY OF RESULTS.—Primary traverse: 253 miles of traverse run, 197 observing tripods and scaffolds built, heights 4 to 40 feet; 197 stations in main scheme occupied for horizontal measures, 150 stations in supplemental schemes occupied for horizontal measures. Triangulation: 350 square miles of area covered, 3 observing tripods and scaffolds built, heights 40 feet each; 6 stations in main scheme occupied for horizontal measures, 6 geographic positions determined. Precise leveling: 277.8 miles of levels run, 358 permanent bench marks established; 7 stations occupied for determination of azimuth.

During the season beginning July 1, 1918, and ending December 29, 1918, the following work was accomplished:

Lines of primary traverse and precise leveling were extended from the vicinity of Seaboard, N. C., to Moncure, N. C., where connection was made with the traverse from Savannah, Ga., over the tracks of the Seaboard Air Line Railway, and from Wilmington, N. C., to Sanford, N. C., over the Atlantic Coast Line Railroad. From Sanford northwestward the character of the country was more favorable for triangulation than for traverse. A scheme of triangulation was started from two adjoining lines of the Norfolk-Savannah traverse as a base and carried 25 miles toward the oblique arc, and connection was made with the triangulation carried down from the oblique arc by C. L. Garner.

On July 1, 1918, the work had been completed to Seaboard, N. C. It was continued from there to Moncure, N. C., where connection was made October 10 with the line run from Savannah northward, a total distance of 136 miles. The entire party and outfit were moved to Wilmington, N. C.

[CLEM L. GARNER.]

SUMMARY OF RESULTS.—Reconnoissance (for primary traverse): Length of scheme 140 miles; 180 points selected for scheme. Primary traverse: 50 square miles of area covered, 180 signal poles erected, 83 observing scaffolds and tripods built, heights from 4 to 70 feet, average height 12 feet, 54 stations in main scheme occupied for horizontal measures, 126 stations in supplemental schemes occupied for horizontal measures, 200 geographic positions determined. Precise leveling: 140 miles of levels run. Azimuth: 3 azimuth stations occupied.

On July 8, 1918, the charge of the primary traverse and precise leveling party of M. E. Lutz was transferred to Clem L. Garner, at Camden, S. C.

During the period between July 12 and October 7, the line of primary traverse and precise leveling was continued from Camden, to which point the work had been carried by M. E. Lutz, to a junction with the work of Max Steinberg at a point about 2 miles to the southward of Moncure, N. C. The traverse followed the Seaboard Air Line Railway for the entire distance.

The field work on the traverse and leveling was done between July 12 and October 7, 1918, a period of two and three-fourths months, during which time the progress was 139 miles, or an average of 50 miles per month. The work was over a very crooked road where the curves were long, and averaged only about three-quarters of a mile apart.

The progress of the leveling was necessarily held down to the same amount of mileage, since the traverse stations were used as bench marks, and the leveling could not be done before the marks had been set and the concrete seasoned at least one day.

Practically all of this work consisted of short traverse lines connected to main-scheme stations several miles apart, thus forming so-called loops. This system increased the cost of the work somewhat, but furnished a valuable means of checking the accuracy of the work.

Several improvements were made in the methods of operation with the object of eliminating some of the errors occurring in traverse work.

During the season a number of photographs were taken to illustrate the operations of the party.

Motor velocipede cars were used for the transportation of the party and instruments.

### GEORGIA, FLORIDA, ALABAMA, AND SOUTH CAROLINA.

[EARL O. HEATON.]

SUMMARY OF RESULTS.—Traverse: 754 miles of traverse line remeasured. Leveling: 4 miles of check levels run.

Between February 15 and March 6, check level work was done by this party at Theodore and Alabama Port, Ala.

On March 7 the observer proceeded to Columbus, Ga., to check the measurements on the traverse line between Columbus, Ga., and Jacksonville, Fla., 266 miles.

Between April 20 and May 13, check measurements were made along the traverse between Callahan, Fla., and Albany, Ga., by way of Valdosta, Ga., a distance of 198 miles; May 16 to May 24, between Everett and Savannah, Ga., a distance of 60 miles; and May 25 to June 30, on the Norfolk-Savannah traverse, between Savannah, Ga., and Cheraw, S. C., a distance of 230 miles.

### NEW YORK.

[O. W. FERGUSON.]

SUMMARY OF RESULTS.—Precise leveling: 88.22 miles of levels run. 57 permanent bench marks established.

In the latter part of April, 1919, a party was organized to run a line of precise levels from Troy, N. Y., to Whitehall, N. Y., and then to proceed to Rouses Point, N. Y., and continue a line of levels westward over the Rutland Railroad.

The party arrived at Troy on May 13, and leveling was begun on the morning of May 19.

Beginning at the old bench marks in the southern part of Troy, the line was run to Whitehall, a distance, including sidelines, of 78.42 miles, finishing there on June 24.

Connection was made with four old bench marks in Troy and three in Whitehall, and with water gauges at Waterford, Saratoga Lake, and Fort Edward. Forty-five old bench marks were recovered and connected with the line of levels, although many others had been destroyed in the construction of the new canal and destruction of the old canal. There were also established, on this line 22, bench marks of the new type, consisting of brass disks set in cement posts and other masonry, and 35 other bench marks cut on stone work.

On June 25 the party was moved to Rouses Point to start the line westward.

At Rouses Point an old bench mark of 1882 in the Chapman block was recovered and connected with the gauge used for construction of the terminal of the barge canal, with bench mark Q–1, 1916, established by Mr. Powell, and with two bench marks established by the Canadian engineers. Twenty-four new cement-post bench marks were constructed, and 9.8 miles of line run to the westward connecting with nine railroad bench marks recovered on the way, thus completing 88.22 miles of line by the end of the fiscal year.

### TEXAS.

[CASPER M. DURGIN.]

SUMMARY OF RESULTS.—Precise leveling: 43 permanent bench marks, 99 miles of levels run.

Between May 4 and June 30, 1919, work was in progress on the line of precise levels from Hillsboro, Tex., to Natchez, Miss. This line begins in the vicinity of Hillsboro, Tex., and follows the Trinity & Brazos Valley Railway to Mexia, Tex. From Mexia it follows the Houston & Texas Central Railway to Mexia Junction, and from Mexia Junction, the Mexia-Nelleva Junction Cut-off of the Houston & Texas Central Railway to Jewett, Tex. Work was progressing on this latter railroad on June 30, 1919.

Hired automobiles and the interurban railway were used to transport the party while doing the leveling from Abbott, Tex., to Schofield, Tex. On the remainder of the work motor velocipede cars were used.

One pilot was necessary to pilot the motor cars over the Houston & Texas Central Railway. The Trinity & Brazos Valley Railway did not require a pilot.

[CASPER M. DURGIN.]

SUMMARY OF RESULTS.—Precise leveling: 335 miles of levels run, 135 permanent bench marks established.

Between September 13, 1918, and March 19, 1919, a line of precise levels was run from Harlingen, Tex., to Eagle Pass, Tex., following as closely as possible the scheme of triangulation along the Rio Grande, and connecting with bench marks of the Coast and Geodetic Survey at Laredo and Eagle Pass, Tex.

Two motor trucks were used for the transportation of the party.

The line of precise levels followed the St. Louis, Brownsville & Mexico Railroad from Harlingen to Samfordyce, Tex., thence along the military road along the Rio Grande to Laredo, Tex. At Laredo it was found advisable to follow the wagon road from Webb, Tex., to Asherton via the Tiendas Ranch, and then follow the main road from Asherton through Carrizo Springs and Cometa to Eagle Pass. In this way, although it meant following a route in some places 30 miles from the Rio Grande, leveling was eliminated from Laredo to Webb, and many creeks and arroyos were avoided. Spur lines were run to several triangulation stations to connect them with the main line of levels and to give a control to the elevations of the triangulation stations determined by vertical angles.

The country over which this line of levels followed was nearly level from Harlingen to Samfordyce. North of Samfordyce the line passed over numerous ridges from 3 to 5 miles apart, and separated by steep valleys, at the bottom of which were deep arroyos.

The total number of bench marks was 135 in a distance of 335 miles, or an average of one permanent bench mark to 2.5 miles.

## FLORIDA.

[DOUGLAS KARR.]

SUMMARY OF RESULTS.—Precise leveling: 150 miles of levels run, 66 permanent bench marks established.

The work in progress at the end of the last fiscal year on the line from Biloxi, Miss., to River Junction, Fla., was continued after July 1, 1918, from a point 15 miles east of Pensacola, Fla., and field work was completed September 23.

Two motor cars were used for the transportation of the party.

## LOUISIANA.

[CASPER M. DURGIN.]

SUMMARY OF RESULTS.—Precise leveling: 158 miles of levels run, 121 permanent bench marks established.

Work on the line of levels extending from Sinton, Tex., to New Orleans, La., was in progress on July 1, having been carried to Jeanerette, La., during the month of June.

At the end of August the line was completed to New Orleans, La., with the exception of the crossing of the Mississippi River, and connecting with some of the bench marks in New Orleans. Two spur lines were run from Baldwin, La., to Weeks Island, La., and from Bayou Sale to South Bend, La.

On September 3 and 6 observations were taken for carrying the levels across the Mississippi River. In this work simultaneous observations were taken from both sides of the river. The length of sights across the river between Avondale and Harahan, La., where the crossing was made, was 1,630 meters.

Connection was made with three bench marks previously established in New Orleans, La.

Transportation for the greater part of June and July was by motor truck. During August and September trains were used entirely, as the truck was in poor condition, and the roads were in many cases unfit for travel owing to heavy rains.

On this line permanent bench marks were established on an average of one to every 1.3 miles. For temporary bench marks lag screws in telegraph poles, squares in abutments of bridges, or the concrete bases of block-signal towers were used.

## OREGON.

[C. A. EGNER.]

In June a party was organized at Klamath Falls, Oreg., to run a line of precise levels from that place into California.

The chief of party arrived at Klamath Falls June 17. From that date until June 24 the time was spent in organizing the party, establishing bench marks, and reconnoissance. Leveling was done on June 26 and 30.

Permanent and temporary bench marks were set from Lelu, Oreg., south to Ady, Oreg., a distance of 26 miles.

The work was in progress at the close of the fiscal year.

### GEORGIA, NORTH CAROLINA, SOUTH CAROLINA, VIRGINIA, AND DISTRICT OF COLUMBIA.

[W. B. FAIRFIELD AND J. E. McGRATH.]

SUMMARY OF RESULTS.—Latitude and longitude: 6 primary latitude stations established, 8 differences of longitude (telegraphic) determined, signals exchanged on 27 nights.

During the period between July 1, 1918, and January 20, 1919, differences of longitude were determined between the following points: Riley, Ga., and Fort Valley, Ga., on July 5, 11, 13, and 14; Fort Valley, Ga., and Norris, Ga., August 8, 12, and 14; Norris, Ga., and Turner, Ga., September 14, 15, and 17; Turner, Ga., and Bethune I, S. C., October 8, 10, and 11; Bethune I, S. C., and Lee, N. C., November 3, 4, 5, and 6; Lee, N. C., and Littleton, N. C., November 20, 23, and 25; Littleton, N. C., and Suffolk, Va., December 16, 19, and 26; Suffolk, Va., and Coast and Geodetic Survey Pier, Washington, D. C., January 11, 12, 13, and 15.

Latitude was determined at the following stations: Fort Valley, Ga., August 4, 1918; Norris, Ga., August 21, 1918; Bethune I, S. C., October 15, 1918; Littleton, N. C., December 4, 1918; Suffolk, Va., January 4, 1918.

Between July 1 and 3, 1918, one of the officers engaged in the longitude work was detailed to revise certain work done in connection with the primary traverse in the vicinity of Macon, Ga.

In the latter part of the season the weather conditions were extremely unfavorable for longitude work.

### TEXAS.

[W. B. FAIRFIELD AND J. E. McGRATH.]

SUMMARY OF RESULTS.—Latitudes and longitudes: One primary latitude station established, one difference of longitude (telegraphic) determined, signals exchanged on 4 nights.

The difference of longitude (telegraphic) between Laredo and La Place (Eagle Pass) was determined on June 4, 6, 11, and 12. Latitude was determined at La Place on June 14.

The Western Union Telegraph Co. rendered every assistance in the use of their lines, and making the necessary connections.

## MAGNETIC WORK.

### MARYLAND (CHELTENHAM MAGNETIC OBSERVATORY).

[GEORGE HARTNELL.]

During the year the work of the Cheltenham Magnetic Observatory was continued in accordance with the usual program.

The two magnetographs were in continuous operation. The Z No. 1 variometer rendered continuous service over a period of 31 months, from April, 1916, to November, 1918, without a shift, the longest record made during the operation of this observatory. The explanation is that the agate knife-edges were very carefully reground by the instrument division in April, 1916. The recording spot was raised in the early part of November of this year by balancing the magnet.

At the time of this adjustment, the magnet was oscillated in situ, both with the damping box in place, and also when removed. The observations were repeated later in the month. The magnet was also removed and oscillated in a horizontal plane. The general conclusion reached was that the scale values derived from the method of oscillations and from deflections were in practical agreement.

The performance of the seismograph has been satisfactory. It is recommended by the observer that a better type of circuit-breaking clock for marking the time be provided. It is also recommended that a new seismograph house be built, or at least the present one be improved or remodeled, so as to obviate the intense humidity of the air that prevails in the room where the seismograph is situated, as the clocks and all the delicate parts of the seismograph are being badly injured by rust.

The special work during the year was the development of the theory of the balanced magnet Z variometer. The application of the theory to the designing of vertical intensity variometers was outlined, and it was shown how a vertical intensity variometer could be made free from drift due to the weakening of the magnets, and to the secular change in the vertical intensity.

W. H. Cullum, magnetic observer, was assigned to Cheltenham Observatory from August 1 to August 20, for training preparatory to taking charge of the Tucson Observatory. In other respects the personnel of the Cheltenham Observatory remains as heretofore.

After September, 1919, although frequently overhauled at the office, earth inductor No. 26 failed to furnish satisfactory observations, and after February 25, earth inductor No. 22 was substituted for it.

The high winds in March caused some damage to the roof of the variation building. This was repaired, and other minor repairs were made.

The chief of the instrument section of the Survey visited the observatory on March 11, for the purpose of testing earth inductor No. 26.

### ILLINOIS.

[Wm. Walter Merrymon.]

**Stations occupied.**—Illinois: Urbana.† Michigan: Kalamazoo.†

Between June 23 and 30, 1919, the three magnetic elements were observed at the two stations named above, both of which were old stations indicated by dagger (†).

### ARIZONA (TUCSON MAGNETIC OBSERVATORY).

[H. E. McComb, July 1, 1918, to July 31, 1918; William H. Cullum, Aug. 1, 1918, to June 30, 1919.]

At the magnetic observatory at Tucson, Ariz., the magnetic instruments have been in almost continuous operation recording variations in declination, horizontal and vertical intensity.

Scale value observations were made at least once a month, and whenever readjustment of instruments made them necessary.

Absolute observations were made once a week except in July.

The Bosch Omori seismograph was in continuous operation except on one day, August 14. Nineteen earthquakes were recorded during the year.

Meteorological observations were made as usual.

Contracts were let near the end of June, 1919, for a new 2,000-gallon water tank, and the erection of a shed to house gasoline and kerosene tanks. These were necessary improvements. The several buildings of the observatory are in good condition.

### ILLINOIS, INDIANA, IOWA, AND MICHIGAN.

[W. W. Merrymon.]

**Stations occupied.**—Illinois: Seneca.‡ Indiana: Cambridge City,‡ Milford,‡ New Castle, and five auxiliary stations, North Manchester,‡ Richmond,* Rochester,* and five auxiliary stations, Schneider,‡ and Walkerton.‡ Iowa: Cambridge,‡ Coon Rapids,‡ Davenport,† Des Moines,* Grinnell,† Herndon,‡ Manning,‡ Madrid,‡ Neola,‡ Peru,† Perry,‡ Rushville.† Michigan: Grand Rapids,‡ and seven auxiliary stations.

Between July 1 and September 14, the three magnetic elements were determined at the places named. Old stations were reoccupied at the places marked by an asterisk (*). New stations were established at places marked by a dagger (†). Stations were occupied, but not permanently marked, at the places marked by a double dagger (‡).

At Davenport, Iowa, the old stations could not be found, and a new station was established.

Auxiliary stations were occupied as follows: Five in the vicinity of Rochester, Ind.; five in the vicinity of New Castle, Ind.; seven in the vicinity of Grand Rapids, Mich.

A meridian line was laid out and marked at the new station at Grand Rapids. This was done at the request of the superintendent of parks and the county surveyor and engineer.

Requests from many surveyors, engineers, and others for magnetic data were received and forwarded to the Washington office.

## ALASKA.

[J. W. MAUPIN, Commanding Steamer *Cosmos*.]

**SUMMARY OF RESULTS.**—Triangulation (tertiary): 28 square miles of area covered, 18 signal poles erected, 16 stations in main scheme occupied for horizontal measures, 18 geographic positions determined. Topography: 16 square miles of area surveyed, 21 miles of coast line surveyed, 4 miles of creeks surveyed, 1 topographic sheet finished, scale 1 : 10,000. Hydrography: 1 square mile of area covered, 34 miles run while sounding, 696 positions determined (double angles), 2,847 soundings made, 3 tidal stations established, 2 hydrographic sheets finished, scale 1 : 2,500.

A party was organized in July, 1918, to make a hydrographic survey of the north end of Wrangell Narrows in vicinity of Petersburg, southeastern Alaska. The steamer *Cosmos* was assigned for the transportation of the party.

Field work began July 25, and closed August 28.

The work contemplated was a close development by sounding, and with the harbor sweep of an area extending from a point opposite Petersburg to the north end of Wrangell Narrows, where the latter empties into Frederick Sound. The harbor sweep was used for the purpose of locating possible bowlders.

Most of the old triangulation stations were recovered, and by the addition of two new stations located by sextant cuts, sufficient control for the work was obtained.

The soundings were taken very close together, and in addition to the depths shown on the sheet, many hours were spent in feeling over the bottom for possible bowlders. The very large scale on which the work was done, and the strong currents running in whirlpools and eddies which would set the launch in all directions at times, made an accurate development extremely difficult.

The harbor-sweep work was attended with so many difficulties that at times it seemed an impossibility to cover the ground by this method. In order to withstand the force of the current it was necessary to use 2-inch pipe on the sweep, which made it very heavy, and it was operated with great difficulty by the few men who could work in the contracted space on the stern of the launch. With a maximum current of 5 knots, the sweep extending 30 feet below the surface of the water, the difficulties in maneuvering the launch to cover accurately an area with a sweep pipe only 6 meters wide were extreme. Each day the party continued work as long as the current would permit, when the pipes would break and make it necessary to lay off for repairs. During the work the sweep broke 12 times, and much time was consumed in repair work. Buoys were planted and located, which helped to keep the launch within the area which was being developed, and by continued effort the ground was covered as closely as possible. The several small spaces between the recorded sweep lines were also covered in maneuvering the launch back and forth during the process of starting a line.

The results obtained agree very closely with the original survey made in 1910. At a point 180 meters N. 60 W. (true) from signal boat, a depth of 12 feet was obtained where 14 feet was previously shown. This is considered one of the crucial spots of the work, and from all reports (including eyewitnesses) it is where several vessels have grounded. After the completion of this survey the superintendent of lighthouses at Ketchikan, Alaska, stated his intentions of placing a buoy on this spot, and a blue print was furnished him by this party for use in locating same.

On August 31 the *Cosmos* left Petersburg for Ketchikan, arriving the same day. After making necessary preparations, including a trip to Metlakatla to obtain equipment needed for work required at Keete Inlet, the vessel left Ketchikan on September 5, arriving at Keete Inlet the same afternoon. On the next day the *Cosmos* was unloaded, a camp, tide staff, and bench marks were established, and on the following day the *Cosmos* proceeded to Craig, Alaska, to remove the automatic tide gauge which had been in operation there. Three days' tidal observations were made simultaneously at Craig and Keete Inlet, and after leveling to the bench marks and removing the tide gauge the *Cosmos* returned to Keete Inlet on September 11.

The season's work at Keete Inlet opened September 11 and closed September 30, during which period there were but 16 working days.

In this time a scheme of triangulation consisting of 18 stations and 8 figures in the main scheme was completed, and 1 topographic sheet was completed.

Keete Inlet was found to extend about twice as far inland as shown on the chart, which proportionately increased the work required to be done.

The *Cosmos* returned to Ketchikan October 6, where a site was selected for a proposed boathouse. Three days were spent in establishing an automatic tide gauge, bench marks, and tide staff at Ketchikan, and two days in laying up the *Cosmos* at Metlakatla.

The party sailed for Seattle on October 19, arriving October 21.

[E. R. HAND.]

SUMMARY OF RESULTS.—Topography: 1 square mile of area surveyed, 5 miles of general coast line surveyed, 1 topographic sheet finished, scale 1:5,000. Hydrography: 1.8 square miles of area covered, 79.7 miles run while sounding, 1,603 positions determined (double angles), 8,763 soundings made, 2 hydrographic sheets finished, scale 1:5,000. Hydrography (wire drag): 24.8 square miles of area dragged, 59.8 miles run while dragging, 2,139 positions determined (double angles), 3 wire-drag sheets finished, scales 1:2,000 and 1:5,000.

The wire-drag survey at Anchorage, Knik Arm, Alaska, in progress at the beginning of the fiscal year, was completed July 28.

On account of the rapid currents in this locality the use of the drag was possible only at the time of slack water, and to insure accuracy, it was necessary to supplement the work of the drag by sounding with the lead over places where the depths appeared doubtful. So far as conditions permitted the drag was set to within 3 to 5 feet of the bottom, and to a depth of about 30 feet. Inside the 30-foot curve the water shoals rapidly, and is not to be regarded as navigable.

No dangers were found of importance to shipping. In the area immediately south of a point midway between Woronzof and Mackenzie, the drag often caught on spots with less water than indicated by the soundings. The drag passed over them all when set at 35 feet. This locality is not in the steamer track of vessels.

The drag was passed a number of times over the previously reported shoal that lies northwestward and a half mile from the proposed wharf. Sounding developed a least depth of 33 feet; the wire brought up at 30 feet but cleared at an effective depth of 27. Vessels should be careful when maneuvering around the new wharf at low tide, but at present it is well up beyond the fairway.

On July 30 the party left Anchorage for Port Chatham, arriving on August 1.

At Port Chatham quarters were found with the Whitney & Lass Mining Co., which is developing valuable chrome ore holdings in the vicinity of Claim Point. Since this company was having difficulties through the refusal of the steamship companies, on account of inadequate surveys, to send vessels to their wharf, and as the immediate need for this ore in munitions making was the determining factor in sending the party to this place, an investigation was first begun of the bight between Kelp and Claim Points where the mine dock is located. A detailed topographic and hydrographic survey was made on a scale of 1:5,000, without finding any hidden obstructions. A beacon and a range were established, and blue prints of the survey made, and on August 23, 23 days after the arrival of the party, vessels began to come to the wharf for ore.

After issuing the chart, operations with the drag showed that shoal water extends farther off Claim Point than previously shown, though nothing dangerous was found. Tracings were made showing the additional soundings off Claim Point, and furnished to those to whom the blue prints had been sent, and one was forwarded to the Seattle field station, that the data might appear on future prints from the original tracing filed there.

No sounding was done at Port Chatham except for the above-mentioned survey, and the plane-table work outside of these consisted in locating signals for the wire-drag operations. The drag work was carried up to the head of Port Chatham over all the navigable area and anchorage ground. The dragging was extended from outside Chatham Island through all the waters of less than 20 fathoms depth across to Elizabeth Island, and over all of the area in the west entrance between this island and the mainland to the 20-fathom curve, running into the bight between Kelp and Claim Points where the mining camp is situated. Spots off the west end of Elizabeth Island and off Koyoktolik Bay, designated in the instructions for this work, were swept over. A group of irregular soundings on chart 8,580 on the east side of the channel between Elizabeth Island and the mainland, and east of the north end of that island, and directly in the steamer track, was dragged over without result.

For the reduction of soundings simultaneous observations of tides were made, and referred to a bench mark established at the head of the port by H. W. Rhodes in 1906. Three permanent tidal bench marks were established on the cliffs at the end of the mine wharf opposite the tide staff.

A small drag handled by a motor dory and a pulling boat was devised for the purpose of sweeping close to the bottom in areas where the longer drag and the launches could not be used to advantage,

About the middle of September the party proceeded to Seldovia to investigate a reported rock near the Anderson wharf. This rock, with 9 feet of water over it, was found 180 feet off this dock. The water front was revised while locating signals.

Work at Seldovia and Port Chatham was completed September 24, and on the 27th the party left for Seattle, Wash., arriving October 13.

Work at Halibut Cove, Kachemak Bay, for which orders had been issued, was not undertaken owing to the lateness of the season.

[J. W. GREEN.]

STATIONS OCCUPIED.—Alaska: Alitak Bay, Anchorage, Chicaloon, Chitina, Cordova, Fairbanks, Fort Liscum, Fort Yukon, Holy Cross, Hot Springs, Kokrines, Matanuska Junction, Montana Creek, Nenana, Nulato, Rampart, and Seward.

Field magnetic observations in Alaska begun in June, 1918, were in progress at the beginning of the fiscal year, two stations, Eagle and Circle, having been occupied.

Between July 1 and the close of the season on October 12 observations of the three magnetic elements were made at the stations named above. Of the Yukon River stations established in 1908, which were reoccupied during this season, only one, that at Circle, could be found. Observations were secured in the immediate vicinity of the old station, and a new station was established nearly a mile south of the former station.

At Fort Yukon, the station which in 1908 was placed about 150 feet from the river bank, was found to be only 20 feet away from the bank, due to the river undermining and cutting away the bank. At this place repeat observations were obtained at the old station, and then a new station was established about one-fourth mile back from the river, in order to insure a determination of the annual change at a future date.

All other stations along the Yukon River were found intact, and most of them in a fair state of preservation.

New stations were established on the Tanana River at Hot Springs, Nenana, and Fairbanks. Stations were established at Chitina and McCarthy along the Copper River Railway; at Cordova, Fort Liscum, and Seward in the vicinity of Prince William Sound; at Anchorage, Matanuska Junction, Chicaloon, and Montana Creek along the new Government railway, and at Alitak Bay at the southern end of Kodiak Island.

After the return of the observer to Sitka comparison observations were obtained with the set of field instruments and the observatory instruments.

### SITKA MAGNETIC OBSERVATORY.

[F. P. ULRICH.]

The usual observations were recorded during the year with practically no interruption.

The magnetic variation instruments have continued in satisfactory operation.

Absolute observations were made each week.

Comparison observations necessary on account of the change in location of the absolute observatory, and for instrumental comparisons, were made in October.

Time corrrections were obtained each week at the local cable office of the United States Signal Corps. Time signals are received each day by cable from Mare Island.

The seismograph was kept in almost continuous operation, and 20 shocks were recorded, all of small magnitude.

A new fence was put around the office lot, a new walk put down, and the grading of the lot was completed. A new azimuth mark was set, and the azimuth determined by angular measurements from the old azimuth mark.

Meteorological observations consisting of temperature and barometer readings, state of the weather, and other meteorological phenomenon were continued.

Necessary repairs were made to the office buildings.

## PORTO RICO.

### VIEQUES MAGNETIC OBSERVATORY.

[WALLACE M. HILL.]

At the magnetic observatory at Vieques, P. R., a practically continuous record was obtained with the magnetograph and seismograph. The usual absolute observations were made of the declination, dip, and horizontal intensity.

Adjustments were made of the D and H variometers, the seismograph, and the earth inductor. Scale-value observations were made once each month, and more frequently when the necessity arose on account of the adjustment of an instrument.

On October 11, a severe earthquake shock occurred at the west end of Porto Rico, and during the remainder of the month a constant succession of tremors of varying intensity were recorded on the seismograph. On November 12 a strong shock was recorded from the same region, and then the tremors practically ceased.

At the beginning of the first severe shock the recording needles were jarred from the pivots of both components, but a good record of the second strong shock was obtained upon the E–W component, although the needle of the N–S component was jarred from the drum.

The two experts, Prof. Reid and Prof. Jagger, who were sent by the Government to investigate the cause and results of this earthquake, visited the observatory, and examined a good typical record made on November 12.

The only instrument disturbed by the earthquake was the D variometer, which was slightly jarred out of level.

Several other strong earthquake shocks, apparently from South America, were also recorded.

Tremors of slight intensity were noted occasionally which had the same general appearance as those occurring during the large disturbances of October, 1918, in Porto Rico.

It was found necessary to make a readjustment of the long magnet of the magnetometer.

Readings of the meteorological instruments were taken each day.

Two compass declinometers were standardized, and special scalings were taken from the magnetograms for the period of the eclipse of May 29, 1919.

## VIRGIN ISLANDS.

[O. W. SWAINSON.]

SUMMARY OF RESULTS.—Reconnoissance: Length of scheme 13 miles, 81 square miles of area covered, 11 lines of intervisibility determined, 7 points selected for scheme. Base lines: 2 secondary base lines measured, lengths 1 mile and 1.77 miles. Triangulation: 506 square miles of area covered, 117 signal poles erected, 5 observing tripods and scaffolds built (heights 6 to 30 feet), 4 observing scaffolds built (heights 10, 12, 14, and 16 feet), 48 stations in main scheme occupied for horizontal measures, 2 stations in supplemental schemes occupied for horizontal measures, 46 stations occupied for vertical measures, 155 geographic positions determined, 48 elevations determined trigonometrically. Leveling: 2 permanent bench marks established, 1.8 miles of levels run. Magnetic work: 5 land stations occupied for magnetic declination. Topography: 58 square miles of area surveyed, 128 miles of detailed shore line surveyed, 10 miles of shore line of ponds surveyed, 86 miles of road surveyed, 9 topographic sheets finished, scale 1:10,000.

On July 1, 1918, the topographic survey of the Virgin Islands, begun in February, 1918, at the request of the Navy Department, was in progress.

The work contemplated included a complete scheme of triangulation extended from the line "East End, Vieques Island to Savana Island," established in 1900; the measurement of a base line on each of the islands of St. Thomas and St. John, detailed topography of the shore line and entire area of the islands on a scale of 1:10,000, with contour intervals of 20 feet, and the determination of magnetic declination with the compass declinometer.

As the survey was undertaken at the request of the Navy Department, the governor of the islands, the civil engineer of the Navy in charge of engineering operation on the islands, and the commanding officer of the naval vessel stationed at St. Thomas were consulted from time to time.

As the result of these consultations several pieces of work were done for the Navy, and tracings of positions of the topographic sheets were furnished when desired.

Up to July 1 the triangulation had been carried as far as the passage between St. Thomas and St. John. From there it was continued eastward until on December 31 the whole scheme in this direction was nearly completed. A few of the most eastern stations remained to be established and occupied.

Five stations were established on neighboring British territory, and sites for two more were selected, making seven in all.

Central-point figures were used rather than quadrilaterals. These gave the greatest number of stations on both sides of the islands of St. Thomas and St. John with which to cut in stations for topographic control with the least number of angles to observe.

Stations were established about 1 mile apart along the shore line, and cut in by triangulation. Flags were placed in trees on top of the prominent hills, and located by triangulation. These were for the topographic control. All stations, except the flags on the hilltops, were permanently marked and described.

At the beginning of the fiscal year about half of the field work on topographic sheets A, B, and C was finished. By December 31 all of these sheets, with the exception of a couple of days' work on outlying islands, which work was prevented by high seas, and sheet E were finished, and about half of sheet D. The office work on sheets B and C was practically completed.

The numerous trails, called roads, were so winding that they were run in most cases by plane-table compass traverses, the elevation being carried forward with the alidade, and checked wherever a triangulation flag was visible. The traverse was checked by three-point fixes wherever possible.

A considerable part of the islands was under cultivation during the slave days, but the islands are now covered by dense growths of vines, bush, and trees from 15 to 30 feet high. This made the interior topography difficult. On this account frequent topographic stations were established and marked along the various trails wherever a good three-point determination could be obtained, so that future surveyors could have plenty of points to which to tie in the land surveys.

Two topographic parties were in continuous operation. Each party was in charge of an officer. There were four men to a party.

In the course of the triangulation tangent cuts were taken to Little Tobago Island, Big Tobago Island, and Watson Rock. These cuts plotted on the existing chart put the islands several hundred meters farther west than shown on the chart. St. Thomas and St. John seem to be fairly correct.

When the arrangements were being made in Washington to begin this survey, it was thought that one year, at the most, would be needed to complete it. However, before the first two topographic sheets were finished, it was seen that the entire survey could not be finished within one year. It was found that the country was more heavily timbered than had been thought, and consequently it was more difficult to obtain the desired accuracy and detail.

By January 1, 1919, the triangulation had been carried as far eastward as Estate Carolina, on St. John, and most of the other stations in the St. John scheme had been established. The base lines of St. Thomas and St. John had been measured. Field work on topographic sheets B, C, and E was completed, and that on sheet A practically so. Sheet D was about half finished and sheet F was just started.

In other words the triangulation of St. Thomas and St. John was nine-tenths finished; five-sixths of the topography of St. Thomas and one-fifth that of St. John were completed.

The triangulation was continued in the same manner as previously. The remaining stations of the St. John scheme were occupied. These included stations on the neighboring British islands.

On February 1, the triangulation in that section being finished, the chief of party broke camp, and moved to St. Thomas, where arrangements were made to move headquarters to St. Croix.

While in St. Thomas the chief of party called upon the Governor of the Virgin Islands to inform him regarding the progress of the survey, and to request the assistance of a submarine chaser when the survey of Frenchman's Cap was made, and when the inter-island triangulation was carried out. The governor said that the matter would be given consideration.

Headquarters were moved to St. Croix on February 9. A month was spent on office work, consisting of getting up the semiannual report, and computing geographic positions.

The party started to build triangulation signals on St. Croix, March 12. A base site was selected, and the base net laid out. The base line was not measured, however, until May 2 as it was desired to have the services of the men from one of the topographic parties when the measuring was done. This was in order to save expenses as well as to have experienced men handling the tape.

In order to have the base line a multiple of 25 meters, and thus avoid a measurement of 10 or 15 meters with the steel pocket tape, one end of the base line was not established until the base-tape support stakes were set. Consequently no triangulation station from which this end of the base line was to be observed on could be occupied until the base was measured, without the necessity of reoccupying the station. Therefore a large part of the base-net scheme was established, and signal poles erected before any observing was done.

A quadrilateral composed of the stations East End (Vieques), Saba, Mount Eagle (St. Croix), and Caledonia (near Hams Bluff Light) was selected as the best means of carrying the geographic position and azimuth over to St. Croix. The observing on this quadrilateral was delayed until all field work on the topography of St. John was finished. Arrangements were made for the use of a submarine chaser to take the party to Vieques, and stand by until the survey was finished.

Everything was in readiness on May 12, so the various light keepers and observers took their stations. The party at each of the four stations had an electric signal lamp, an acetylene signal lamp, and a heliotrope.

Atmospheric conditions were bad the first week, but all of the observing at the four stations was completed the second week. Four sets of observations were taken. A set consisted of six measures of each angle with the telescope direct, and six of the explement with the telescope reversed.

The electric lamps were found to give the best satisfaction. They threw a smaller but stronger beam of light than the acetylene lamps, and, consequently, could be seen better by the observer. The heliotropes could not be seen over the long sides and diagonals except occasionally. The longest distance was 63,418 meters.

After the interisland triangulation was completed all parties were moved to St. Croix. There the topographers did office work on their St. Thomas and St. John sheets, the chief of party carried on the triangulation, and the new officer sent down to relieve one of the others did computing.

At the close of the fiscal year the triangulation of St. Croix had been extended from the western end of the island to Christiansted.

Two topographic parties were kept in the field as previously. They finished the topography of St. Thomas on February 10, and of St. John on May 3. The topographers then assisted in the interisland triangulation, after which they did office work on their sheets. It was desired to send the sheets to Washington as soon as possible, therefore no field work on St. Croix was allowed to interfere with the completion of these sheets for mailing. A field draftsman assisted in the inking of the sheets.

An automobile was used for the triangulation on St. Croix. This proved to be an efficient method of transportation.

A submarine chaser was placed at the disposal of the party for the survey of Frenchmans Cap and the interisland triangulation.

Endeavor was made to comply with the wishes of the Navy officials, and for that purpose frequent consultations were had with the various aids to the governor. They, in their turn, were very courteous, and rendered all possible assistance to the party.

## HAWAIIAN ISLANDS.

### HONOLULU MAGNETIC OBSERVATORY.

[FRANK NEUMANN.]

At the magnetic observatory at Ewa, Hawaii, the three magnetic variometers were kept in continuous operation, and double sets of absolute observations were made weekly, in order to determine base-line values. Scale-value observations were made monthly on the two intensity variometers as heretofore. Very little trouble was experienced with the working of these instruments, and the only abrupt changes of base line occurred when necessary adjustments were made in December. The scale value at the Z variometer shows a uniform increase.

The Milne seismograph was also kept in continuous operation, and all earthquakes were recorded. As the past winter was one of the driest in years, no trouble was experienced on account of humidity or tilting of the pendulum.

All computations and tabulations were submitted as heretofore. Base-line values were determined, and the hourly means of the three magnetic variometer traces were tabulated—also maximum and minimum ordinates. Reports were also submitted of all earthquakes. Time observations were made three or four times a month with a sextant.

Meteorological observations were made as follows: Antemeridian, inside and outside humidity; postmeridian, outside humidity, maximum and minimum temperatures, and rainfall. Outside thermograph traces were obtained and the general state of the weather noted. Monthly reports were submitted to the local Weather Bureau office in Honolulu.

## PHILIPPINE ISLANDS.

[FREMONT MORSE, Director of Coast Surveys, July 1, 1918, to Feb. 10, 1919; HUGH C. DENSON, Director of Coast Surveys, Feb. 11, 1919, to June 30, 1919.]

During the year the field work of the survey was with a reduced force, the number of ships in commission being three—the *Pathfinder*, *Fathomer*, and *Romblon*, instead of the five that were continuously employed previous to the war.

In consequence of this reduction in force the output of field sheets was curtailed, and also the output of finished drawings from the Manila office. The latter was also affected by the outbreak of Spanish influenza in Manila, which at one time resulted in the absence of more than one-half of the office force.

The same disease ran its course among the complements of the surveying vessels. First, and in a mild form, it went through the *Fathomer;* later it laid up the crew and officers of the *Romblon;* and finally, in a more severe form, it struck the *Pathfinder* while she was engaged in her regular work on the Palawan coast, and took toll of eight lives from among the Filipino crew before it was finally overcome. It should be stated that the victims were among those who had joined the ship at Puerta Princesa or had been previously subject to the malarial fevers which are so prevalent on the Palawan coast.

There were no changes in personnel in the office during the period covered by this report and the routine continued as usual.

Tracings for two new charts and two complete new editions of charts and four tracings for correction pieces, were forwarded to the Washington office, besides miscellaneous corrections and new information for reprints of other charts. On June 30 there were 10 chart drawings, consisting of new charts, new editions, or correction pieces, in progress.

More than the usual amount of miscellaneous work was done in furnishing navigators with advance information, and the military, naval, and insular authorities with tracings of field sheets, or blue prints from those tracings.

The computing division continued as usual to care for the triangulation and tidal records, furnish data to the various United States Government and insular authorities as requested, and to keep up the office computations.

The chart division attended to the sale of charts and other publications, and distributed Sections VI and VII of the Philippine Islands Sailing Directions, which were received from the printer subsequent to July 1. The manuscript copy of Philippine Coast Pilot, Part I, was completed in August, and sent to Washington to be printed.

The geographical division of the office continued the work of preparing topographical maps of various sections of the islands. The tracings for map No. 6 were forwarded to Washington to be printed in December. This map covers the eastern part of central Luzon. Map No. 100, covering the entire Archipelago on a scale of 1:1,000,000, was in process of printing during the first half of the fiscal year. Four other topographic maps were in hand on June 30 in various stages of preparation.

Regular meetings of the Philippine Committee on Geographical Names were held monthly, and a great amount of work was accomplished toward correcting and unifying the spelling of names of the barrios of the island. The card index of these names was completed, and has been of great assistance. By its help much has been done to make the spelling of the same names alike in the various Provinces.

[A. M. Sobieralski, Commanding Steamer *Pathfinder*.]

Summary of results.—Triangulation: 122 square miles of area covered, 11 signal poles erected, 1 observing tripod and scaffold built (height 104 feet), 8 stations in main scheme occupied for horizontal measures, 18 stations in supplemental schemes occupied for horizontal measures, 5 stations occupied for vertical measures, 24 geographic positions determined, 12 elevations determined trogonometrically. Topography: 404 square miles of area surveyed, 98 miles of general coast line surveyed, 56 miles of shore line of rivers surveyed, 4 miles of shore line of creeks surveyed, 22 miles of roads surveyed, 7 topographic sheets finished, scales 1:20,000, 1:40,000, and 1:10,000. Hydrography: 352.9 square miles of area covered, 3,277.6 miles run while sounding, 59,841 soundings made, 14 tidal stations established, 4 current stations occupied, 7 hydrographic sheets finished, scales 1:20,000, 1:40,000, and 1:80,000.

On July 1, 1918, the steamer *Pathfinder* was at Puerto Princesa, Palawan. The party was engaged on the expansion net from the Iwahig base.

This base line is on level ground in a valley surrounded by high mountains, and to expand from the base to the main scheme triangulation, it was necessary to occupy four mountain peaks, Mount Beaufort, Thumb Peak, Stavely, and Central. Each of these peaks is above 3,000 feet, and 6 to 10 miles inland, making it an arduous task to reach and occupy them. Besides, the observations were hampered by smoky, hazy weather. On account of the poor visibility and, probably, on account of the great difference of elevation between stations, the observations were not as good as in the rest of the main scheme, but were within the requirements of accuracy.

While these observations were in progress, the ship and one launch party were engaged on hydrography and topography to the southward of Calver Point.

During the early part of August the ship was at Manila for minor repairs and supplies.

Upon the return of the ship to the working grounds, work on the hydrography and topography was resumed. Two stations in the main scheme, Calatugas and Albion Head, were reoccupied.

On September 15, the ship was called to Manila to certify to repair vouchers. As the ship took coal at the same time, this did not interfere materially with the work, although Mr. Auld was left at a distant triangulation station for 26 days, and had to live on the country most of the time.

During October the boilers were cleaned at Puerto Princesa, and at the same time the party was engaged on a special tidal investigation.

By October 27 the northeast monsoon was well established in full force. The work was hampered not only by the heavy wind and sea but even more by the haze which always accompanies a strong wind that brings rain.

On November 8 the whole ship's complement, officers and men, was taken ill with Spanish influenza. Nothing had been heard of the spread of this disease throughout the world, and it alarmed the party all the more for that reason. It proved very serious. Eight of the crew died, and many others did not recover completely for over a month. The director sent the *Romblon* with an additional medical officer, and the ship had to return to Manila in order to secure hospital accommodations; the crew was in no condition to do any work, but most of the men who were ill requested their discharges, and on December 8 the ship returned to the working grounds with practically a new crew.

The results of the season's work were as follows:

*Triangulation.*—The Iwahig base was connected to the main scheme, on the line Thumb Peak–Central. The two values of this line as computed in the field check very closely.

Two stations in the main scheme, Calatugas and Albion Head, were reoccupied to observe some angles which had been omitted in the previous season's work.

The supplementary scheme of triangulation was extended to Bivouac Point, where it joins the main scheme. This system starts from the main-scheme line Arena–Sombrero and extends northward to the station Prom, which is connected with the main scheme; and it has now been connected with the main scheme at the southern end, so that the whole system can be adjusted to fit the main scheme.

*Topography.*—The topography of Puerto Princesa was completed. On this sheet were included all of the town of Puerto Princesa and all of the Iwahig Penal Colony. These settlements, together with the numerous streams entering the bay, made so much detail that it took a long time to complete the sheet, while the difficult country, mostly mangrove swamps, made it an arduous task.

The topography was extended from Calver Point to Relief Point, where it joins the work of the steamer *Romblon* at triangulation station Shore, thus completing the topography of the east coast of Palawan.

Tagalinog Island was completed on a separate sheet on a scale of 1:10,000.

In order to show the contours from Inagauan to Bivouac Point it was necessary to lay out a 1:40,000 sheet, as the mountains are well back from the coast, beyond the limits of a 1:20,000.

*Hydrography.*—The hydrography of Puerto Princesa was completed, all the intricate area in the northern part of the bay being closely developed. This fine harbor will some day be of much more importance than at present.

A good typhoon anchorage was developed back of Malanao Island, but the reported passage was found so narrow and tortuous as to be impracticable.

The large number of shoals off the coast between Aborlan and Panacan required an unusual amount of close development.

A good clear channel, though narrow, as well as an excellent anchorage in northeast weather were developed between Rasa Island and the mainland.

The inshore work was carried to Bivouac Point.

It was planned to finish the ship work to a line north of Tagalinog Island, but the unusually hazy weather during the southwest monsoon, together with the fact that the northeast monsoon set in earlier than was expected, made it impossible to carry out this plan. An area of about 28 square miles east of Rasa Island remains to be completed; another area of about 8 square miles south of Rasa Island could not be finished; otherwise the hydrography is completed out to the 100-fathom curve to a line south of Bivouac Point.

Altnacraig Shoal was developed, and a 1-fathom spot found remarkably close to the position indicated on the chart; but there seems to be much shoal water to the southward which has not been examined.

An area of about 8 square miles near Tagalinog Island was examined, while a party was building a tall hydrographic signal on the island.

No sounding tubes were used in this season's work, all soundings being taken either with a hand lead (up to 40 fathoms) or up and down with wire.

An automatic tide gauge was kept in continuous operation at Puerto Princesa. Tide staffs were established at Aborlan and Panacan, and read when hydrography was in progress in the vicinity.

A special tidal investigation was made of the remarkable seiches in Puerto Princesa. Ten tide staffs were simultaneously observed, while currents were observed at the entrance. The results are as predicted, the seiches are almost simultaneous all over the bay, being very slight at the entrance and increasing in amplitude toward the head of the bay. Several fine series of oscillations were recorded.

Puerto Princesa was made the headquarters of the ship, although coal was obtained at Manila, a run of 360 miles.

The work was much appreciated by the people in Palawan. Everyone here is directly or indirectly interested in shipping, and they have had so much difficulty in getting vessels to come here, on account of the unreliability of former charts, that it is natural for them to be interested. But they show an intelligent appreciation of the enormous amount of work and expense necessary to carry out the work, and they have been most willing to cooperate in any way possible.

Information was furnished to the masters of the following vessels: *Mindanao*, *Midget*, *Poseidon*, *Pilar*, *Alphonso*, *Palawan*, and *Capt. Coppens*, besides the provincial authorities and various shippers.

On January 1, 1919, the steamer *Pathfinder* was engaged on the survey of the east coast of Palawan in the vicinity of Rasa Island. Although the northeast monsoon is usually very strong at this time, a typhoon which passed to the northward in the latter part of December caused a cessation of the strong northeast winds; taking advantage of this spell of good weather, it was possible to fill in all the gaps in the work, and leave it with no "splits."

The ship and one launch party were kept in operation up to January 17. On the following day the northeast monsoon set in strong again, and work could not be continued, so the ship returned to Manila for repairs, after taking some coal and dismantling the tide gauge at Puerto Princesa.

As a result of this month's work, all the hydrography was completed out to the 100-fathom curve east of longitude 117° 59′ and north of latitude 9° 00′. The inshore hydrography was extended a few miles to the westward of this line.

Current observations were taken while the ship was anchored on some of the offshore reefs. The series were too short to be of much value, but it appears that the current is much stronger near the 100-fathom curve, which here follows the edge of a shelf, than farther inshore.

The ship arrived at Manila on January 24. The boilers were cleaned, and then the vessel proceeded to Olongapo for repairs. Instructions from the office required competitive bids, so the vessel returned to Manila. The bids were opened on February 24, and the results wirelessed to Washington; owing to an unfortunate delay in the transmission of the messages, no answer was received until March 8. As soon as authority had been received, the vessel proceeded to Olongapo, arriving on March 10. Work on the repairs was immediately begun, and on March 11 the vessel was docked. On March 15 the command of the vessel was temporarily transferred to Robert J. Auld, jr.

[E. R. HAND, Commanding Steamer *Pathfinder*, Apr. 16 to June 30, 1919.]

SUMMARY OF RESULTS.—Magnetic work: Ship completely swung at 2 sea stations. Hydrography: 12,661 square miles of area covered, 3,724 miles run while sounding, 99 positions determined (double angles), 165 positions determined astronomically, 733 soundings made, 1 hydrographic sheet finished, scale of hydrographic sheets 1 : 200,000 and 1 : 400,000.

On March 29 when the command of the *Pathfinder* was transferred, the vessel was undergoing repairs at the Olongapo Naval Station. The vessel left the station with some items of repairs uncompleted, and arrived in Manila April 1.

After making the necessary preparations the vessel left Manila April 11 under instructions for deep-sea hydrographic work in the Sulu Sea.

The vessel arrived at Puerto Princesa, Palawan, on April 14, and on the morning of April 16 started east on the initial line of soundings.

The instructions called for deep-sea sounding exclusively, and in the Sulu Sea. The work was to be shown on two sheets. Sheet No. 1 covered a triangular area just outside Puerto Princesa. Sheet 2 (starting immediately below No. 1) provided for the development of an east and west strip over 200 miles in length between parallels 9° and 9° 32′ extending from the known soundings at the Palawan coast on the west to the limits of old work along the Negros shore on the east. The requirements of these orders were in substance as follows: Lines should be run east and west, with a spacing and sounding interval not to exceed 5 miles. A line once started to be carried without interruption to its conclusion, a requirement obviously necessitating day and night running. Careful and consistent watch for new dangers. Ends of lines to be tied to shore fixes, and offshore positions plotted by that astronomical method giving the utmost accuracy considering the time, conditions, and bodies available, or in lieu of better means, by dead reckoning strengthened by careful attention to correct compass deviations, well rated log, engine turns and time, wind and current velocities and directions; special attention, by means of split lines and shortened sounding intervals, to that ridge which appears to trend northeast and southwest through the center of the Sulu Sea. Careful record to be kept of all navigational work, and astronomical computations to be submitted with the sheets at the end of the season.

The orders outlined in the above paragraph were carried out.

Work was continued until June 20, when the vessel returned to Manila for the completion of repairs.

A careful search was made for Rubi Reef reported in 1902. An area of 600 square miles was covered with lines about 2½ miles apart, and soundings at the same interval. The bottom was found to be regular, sloping gently toward a 550-fathom spot over 20 miles to the northward. The soundings in the locality of the reported danger run 700 fathoms and over. It is recommended that Rubi Reef be removed from the chart.

[H. B. CAMPBELL, Commanding Steamer *Romblon*.]

SUMMARY OF RESULTS.—Triangulation: 115.2 square miles of area covered, 1 signal pole erected, 1 station in main scheme occupied for horizontal measures, 7 stations in supplemental schemes occupied for horizontal measures, 8 geographic positions determined. Leveling: 2 permanent bench marks established, 0.2 mile of levels run. Topography: 102.4 square miles of area surveyed, 66.5 miles of general coast line surveyed, 1.7 miles of shore line of rivers surveyed, 3 topographic sheets finished, scale 1 : 20,000. Hydrography: 608.7 square miles of area covered, 3,524.2 miles run while sounding, 9,071 positions determined (double angles), 56,965 soundings made, 2 tidal stations established, 3 hydrographic sheets finished, scales 1 : 20,000 and 1 : 40,900.

On July 1, 1918, the *Romblon* left the working grounds for Manila, arriving on July 4. Minor repairs were completed, stores were on board, and the ship was ready to sail on July 22, but was delayed until July 26 by distant typhoons.

From August 2 to October 9 work was continued off the southeast coast of Palawan, and three trips to Sandakan, British North Borneo, were made for coal. On each of these trips two camp parties were left on the working grounds.

Leaving for Manila on October 10, the vessel arrived October 12, and was ready to sail on October 25, on which date the epidemic of Spanish influenza laid up 15 men. Spreading rapidly to all hands, the epidemic held the party in Manila until November 12, when, by transferring some of the crew of the *Fathomer* to the *Romblon*, it was possible to go to the assistance of the *Pathfinder* at Puerto Princesa, in accordance with orders.

Arriving in Puerto Princesa on November 14, on November 16 five men were transferred from the engineer force of the *Romblon* to the *Pathfinder*, to enable the latter vessel to get to Manila. From then until November 25, there were from three to five men sick on the *Romblon*, and it was not thought advisable to go to the working grounds where the vessel would be very short handed, as well as out of reach of medical assistance should it be needed.

On November 26 the ship arrived on the working grounds, and continued work until December 19, making one trip to Sandakan for coal. During this trip to Sandakan one camp party was left in the field. The *Romblon* sailed for Manila December 20, stopping at Puerto Princesa for coal, and arrived in Manila on December 23. On December 24 the boiler was blown down and general overhauling began.

Both the ship and the launch were engaged continuously on hydrography when the weather was favorable, the launch working from camp the greater part of the time.

In spite of every effort being made by the party on the ship to complete the southern portion of the work below Brooke Point, the plan failed on account of weather conditions. The work was then taken up closer inshore, between Brooke Point and Island Bay. In this locality a system of 1,200 meter lines was run offshore, outside the launch work, as far as signals could usually be seen. In the deeper water outside this area, lines parallel to the coast were run, whenever the weather permitted and there was occasion for the ship to run up or down the coast.

After the monsoon changed to northeast, the ship worked outside and near Island Bay, keeping near the anchorage and running as short a distance as possible to and from work.

On the runs to Sandakan, the ship sounded whenever the weather was at all favorable. This resulted in six lines from the working grounds to Cagayan Sulu, along the 100-fathom curve, and in three lines from Cagayan Sulu to the locality of Taganak Island.

The launch party, working from a camp about 15 miles south of Brooke Point, spent about two weeks developing shoals in that locality. When the monsoon changed, inshore work on the exposed coast was discontinued, and the launch worked in and off Island Bay.

On October 21 and 22 sounding was done inside the breakwater in Manila Harbor by a party from the *Romblon*, using a whaleboat and the launch.

Two topographic sheets were completed, and a juncture was effected with the work of the party on the *Pathfinder*, at triangulation station Shore.

The only triangulation done was the determination of the positions of eight new stations, to be used for the purpose of control in and to the south of Island Bay. Seven of these stations were built prior to July 1. All observing was done after that date.

From August 5 to October 5 a staff was read at Brooke Point from 6 a. m. to 6 p. m., and an automatic gauge was maintained in Island Bay. From November 26 to December 19, only the gauge in Island Bay was operated.

No currents were observed during this period.

Even early in August, when this season began, the haze was troublesome. It steadily grew worse, and late in September, there were times when the shore could not be distinguished at less than 10 miles. The clouds also gave more trouble than early in the year, the peaks usually being covered except for a very short time at sunrise or sunset.

When the party arrived on the working grounds in November, the northeast monsoon had set in, and the parties worked from Island Bay, where a good anchorage was to be had. Very little work was done by the ship at this time. Even when signals could be seen, and the sea was smooth enough to permit work, the facts still remained that, on account of the continual sea and clouded sky, shoals could not be seen, and bottom was barely visible at 5 to 6 fathoms.

and this in a locality where there are not only many shoals, but where they are very steep-to.

On October 12 while approaching Manila, the *Romblon* was signaled by the steamer *Palawan*, which was disabled by engine trouble near San Nicolas Shoal Light. At their request the *Romblon* towed the *Palawan* to the breakwater at Manila.

During the influenza epidemic, November 19 to 21, the *Romblon* made one trip from Puerto Princesa to Brooke Point, taking medicine and assistance to the natives. This trip was made at the urgent request of the provincial governor at a time when field work was impossible because of the weather. The coal burned on this trip was replaced by the provincial government.

From January 1 to May 13 the *Romblon* was tied up at Engineer Island, Manila, undergoing repairs. During this period the ship's crew was engaged in overhauling machinery, scaling, painting, etc.

In accordance with instructions dated February 25, 1919, two officers with a launch party from the *Romblon* were engaged in hydrography on Laguna de Bay from March 3 to April 19. The topography in this locality was found to be incorrect in places, and from March 18 to April 9 a third officer with a topographic party from the vessel was assigned to that work.

Upon the completion of repairs, on May 13, six months' stores were on board, coal was taken at Cavite, and the vessel sailed for the working grounds under instructions of the Director of Coast Surveys, dated April 29, 1919.

The party arrived at Guinayangan, Tayabas Province, on May 15, and work was at once begun. On June 13, it was necessary to leave for coal. Two topographic parties and one hydrographic party were left in the field and the ship sailed for Manila, arriving on June 16.

A few minor but essential repairs were made at Engineer Island, and on June 23 the vessel left for Cavite, where coaling was completed June 24. Sailing direct from Cavite on that date, the vessel was delayed by rough weather and a low barometer, and did not reach the working grounds until June 28.

The field work had progressed satisfactorily, and leaving two parties in camp, the vessel proceeded on June 29 to Port Pusgo, where she was anchored on June 30, waiting for the barometer to rise.

The triangulation in the locality of Laguna de Bay was not done by this party. However, it was used as control for the hydrography executed by the party from this vessel.

Referring to the triangulation at the head of Ragay Gulf near the mouth of the Guinayangan River, stations Guinayangan, Garcia, and Nasua were recovered without difficulty, and from the line Guinayangan to Garcia a scheme is being extended up the river. Before any observing was done, intersection stations were built, and these, with the built-up main-scheme stations, have furnished excellent control for hydrography and topography.

It was necessary in the river, because of the overhanging mangrove, to build tripods for observing. This greatly retarded the progress of the work, and, probably on account of the strong current, affected its accuracy somewhat.

The hydrography done by the party on Laguna de Bay was very thoroughly covered in the descriptive report accompanying the hydrographic sheets.

At Guinayangan, as the sounding barely extends outside the 5-fathom curve, it was all done by launch or whaleboat.

The launch was used from the southern limit of the work up to the bar at the river mouth. The depth varies from about 6 fathoms to 10 feet, at low water. The launch was run as slow as possible, and the soundings spaced as closely as could be done with one leadsman. The greater part of the area, that inside the 5-fathom curve, was covered with 50-meter lines. Outside the 5-fathom curve a few lines 100 meters apart were run, and the soundings were also spread slightly farther apart.

From a depth of about 10 feet, northward—that is, on the bar itself—the whaleboat only was used. Fifty-meter lines were run, and soundings taken much more closely than would be possible with the launch. Under about 9 feet, a sounding pole was used. From the whaleboat all soundings were read to the lesser half foot.

The control for the work consisted of triangulation stations and intersection stations, supplemented by topographic flags.

At Laguna de Bay the topography consisted only of revision and adjustment of such shore line as was found to be very much out by the hydrographic party. The usual topographic methods were used.

At Guinayangan two sheets are partially completed. A 1:10,000 scale, which covers the area outside the river mouth, is nearly finished, and a 1:5,000 scale, covering the lower portion of the river, is about half finished.

Good control is afforded on both of these sheets by the numerous triangulation stations. On the 1:5,000 sheet considerable delay is being caused by having to wait for low water.

On May 19 installation of the automatic gauge at Guinayangan was completed. There was trouble in getting a satisfactory curve, but this difficulty has probably been overcome by the change in the location of the gauge made on June 2 and 3.

On May 16 a tide staff was erected at Alunero. Since then readings were taken from 7 a. m. to 5 p. m. six days a week.

[S. D. WINSHIP, Commanding Steamer *Fathomer*.]

SUMMARY OF RESULTS.—Triangulation: 8 stations in supplemental schemes occupied for horizontal measures, 8 geographic positions determined. Magnetic work: Ship completely swung at one sea station. Topography: 0.2 square mile of area surveyed, 6 miles of general coast line surveyed, scale of topographic sheets 1:20,000. Hydrography: 1,131.3 square miles of area covered, 19,765 miles run while sounding, 21,169 soundings made, 3 hydrographic sheets finished, scales 1:20,000, 1:40,000, and 1:80,000.

Work in the Cuyo group, on which this party was engaged at the end of the previous fiscal year, was continued until July 12, when orders were received to return to Manila for repairs.

While the party was in Manila, some little work was done around the mouth of the Pasig River and inside the breakwater, under special instructions from the Director. At the request of the commandant of the navy yard at Cavite an officer was detailed to determine the angles of visibility of Sangly Point Light.

During the latter part of July the majority of the crew was taken with Trancazo, or Spanish influenza. On one occasion for several days only two men could be mustered on deck. Fortunately no fatalities occurred.

Before returning to the work in Cuyo West Pass, five days were spent in the vicinity of Ilog Anchorage, north coast of Mindoro, looking for two reported shoals, neither of which was found.

September 11 found the party again in Cuyo West Pass. On account of poor seeing conditions it was impossible to complete the triangulation connecting the Dalanganem Islands to the main scheme, though constant effort was directed toward it. The months of May and June are the best suited for triangulation in that locality. Sufficient points were determined, however, to carry on the hydrography indefinitely.

After coaling once in Iloilo, shortage of funds made it necessary to coal in Borneo. On two trips to Sandakan, British North Borneo, two sounding lines were run as far as North Tubbataha Reef.

On October 25, while returning from Sandakan, the *Fathomer* grounded on North Tubbataha Reef, under conditions described in a special report. It was an uncomfortable experience for all hands, though they were favored with the best of good fortune in getting off without aid and returning to Manila under their own steam. The *Fathomer* is the third of three vessels to pile up on Black Rock in the past three years and the only one to get off without help.

On arrival in Manila on November 1 it was found that all shipyards were so busy that no repairs could be undertaken on the *Fathomer* until January. As it did not seem advisable to work the ship during heavy weather of the northeast monsoon until the condition of the hull was known, the ship was tied up to await repairs. In the meantime the crew was retained and the entire ship, both inside and out, was given a thorough overhauling, which was badly needed.

While in the field the party had no headquarters. A tide staff was maintained at Araceli, Palawan, a party camped most of the time in the Dalanganem Islands, mail came to Cuyo, and the ship anchored on the nearest shoal or drifted if no anchorage was handy.

From January 1 to April 15 the *Fathomer* laid at Engineers Island, Manila, undergoing repairs. During this period she received a thorough overhauling, supervised almost continually by two officers. The other officers, while not engaged in some special assignment, applied themselves to the field records of the preceding period.

During February a reconnoissance was made of Laguna de Bay, and preparations made to start a survey early in March.

The Laguna de Bay party started March 1, in charge of an officer who was attached on that date for that purpose. He had with him another officer and a crew of seven men from this vessel, using the ship's launch and cutter. This party executed hydrography on a 1:40,000 sheet, until April 10, when the party was recalled, as the ship was leaving for the south.

On April 15 the ship left for the working grounds.

The assignment consisted of hydrography, topography, and triangulation. The unfinished triangulation and topography of the Dalanganem Islands had to be done, as well as a complete survey made of the Cagayan Islands. The triangulation of the Dalanganems was completed, except one long line which has baffled all attempts. The topography was soon completed, however, and a party placed on the Cagayan Islands to reconnoiter, lay out a triangulation scheme, and do the observing. At the close of June this was about two-thirds finished.

The principal work is the hydrography. It consists of a 1:20,000 sheet of the Dalanganem Islands, a 1:80,000 sheet of Cuyo West Pass, on which the party has been working for a year, and a 1:200,000 of the northern part of the Sulu Sea, extending, roughly, from Piedra Blanca south to the Cagayan Islands, west to Rubi Reef, north to Dumaran Island, and east to Piedra Blanca, besides the two small sheets of the Cagayan Islands, which have not been touched.

The 1:80,000 sheet was worked on whenever possible, the distance run for coal cutting the available time to from 8 to 12 days per month. On those days, however, the ship almost invariably worked 12 hours a day, with two watches, thus taking advantage of all the daylight hours.

The 1:200,000 sheet is all deep water, from 600 to 900 fathoms, with about 25 soundings of greater depth in the southeastern portion. When going for coal, a line was run both going and coming, fixing each end to shore objects and controlling the rest by astronomical observations.

In addition there are two sheets covering the Cagayan waters themselves. One, 1:20,000, takes in the intimate waters of the group, the other, 1:40,000, takes the reefs and shoals to the northeastward. No work has been done on these sheets.

During the entire period a tide gauge was maintained at Araceli, Dumaran Island, Palawan. Mail was received at Cuyo, and coal at Sandakan, British North Borneo.

After June 3 a camp party, consisting of one officer and five men, was maintained on the Cagayan Islands, occupied in reconnoissance and triangulation.

On June 29 the ship returned to Manila, under orders from the Director, leaving a party in the field. On the following day accounts were closed, inventories were signed, and the command turned over to another officer under orders from the superintendent.

## SPECIAL DUTY.

### INSPECTION OF AERONAUTICAL EXHIBITS AT MADISON SQUARE GARDEN, NEW YORK, N. Y.

[E. G. FISCHER.]

On March 13 an inspection was made of the aeronautical exhibits at Madison Square Garden and the Sixty-ninth Regiment Armory, New York, with a view to gaining such knowledge of recent developments in such scientific instruments and apparatus as might be advantageously used in the work of the Coast and Geodetic Survey. The exhibit illustrating the latest advances in aerial surveying was also examined.

The part of the exhibit most directly relating to the work in which the Coast and Geodetic Survey is engaged, that of photographic surveying from the air, was highly interesting, and particularly so on account of the very short space of time in which a plan of an extended area can be photographed, enlarged, and assembled into a complete whole.

It is claimed that trained men can obtain the photographs for mapping an area of 30 square miles in one hour's flight. A map of the route from Fort Sill to Wichita Falls was made from 4,200 exposures obtained in 60 flying hours, by students in training. But, as the topographer on the ground, having before him the altitudes of the points he establishes almost in their linear extent, but being obliged to shift his station frequently to observe and establish horizontal distances, the aerial topographer, inversely, at once obtains all the latter, but only limited information as to the heights of the points established.

Information was obtained in regard to available maps produced by this method, and also in regard to a new aluminum alloy known as "acieral," of which samples were obtained for testing with a view to possible use in the construction of instruments.

### DISTRICT OF COLUMBIA.

[H. G. AVERS.]

SUMMARY OF RESULTS.—Topography: 2 acres of area surveyed, 1 topographic sheet finished, scale 1 inch to 20 feet.

In October, at the request of the Supervising Architect of the Treasury Department, elevations were determined at 20-foot intervals of the grounds in the rear of the Hygienic Laboratory, Washington, D. C.

This plot had been surveyed originally by George D. Cowie in 1912, but several changes that had been made in the grades necessitated a resurvey before plans for a contemplated new building could be drawn.

The results of the survey were plotted on a sheet on scale of 1 inch to 20 feet and furnished to the office of the Supervising Architect.

Two assistants to act as recorder and rodman were furnished by the Supervising Architect's office and the work was done without expense to the Survey.

[F. B. T. SIEMS.]

In conformity with a request from the Navy Department, a trial course 1 nautical mile in length was established for the use of the naval air station at Anacostia, D. C.

The Navy Department furnished the boats, men, and material necessary for this work and field work was in progress on April 3, 4, 7, 9, and 10, 1919.

The method of establishing the course consisted of selecting a point A, on the United States naval magazine wharf, Bellevue, readily located by triangulation, and to serve as a point on the southern range of the trial course. A suitable course for hydroplanes was laid off on hydrographic sheet, scale 1:10,000, along the east edge of main channel 1 mile north of A; allowing also for a safe depth of water for the approaching and leaving course. This course was found to be 14° N. 19′ E.

A point distant 1 nautical mile northwest from A, along the azimuth line 14° N. 14′ E., was platted on topographic sheet, scale 1:4,800, and the point C, on the ground corresponding to the platted position, was selected by identifying certain topographic features in the locality. A and C, however, were found not to be intervisible; it was impossible to find two such points 1 mile apart located on this shore.

The two points, A and C, were located by triangulation—the azimuth from A to C was found to be 14° N. 20′ 50″ S., and the distance between them 1,928.27 meters, exceeding 1 nautical mile (1,853.25 meters) by 75.02 meters. It is seen that azimuth A to C is practically the same as that of the course itself, and for the sake of simplifying the computations the azimuth N. 14° 20′ 50″ was adopted. The azimuths of the ranges, therefore, would be 104° N. 20′ 50″ E.

It remained now to locate a point B on the northern range distant 1 mile from A, or 75.02 meters from C, if measured in a direction toward A. It was necessary, however, to measure a distance along edge of bluff on a line 18° 30′ to the left of the direction C to A, or 79.11 meters, establishing the point B on the north range. (The measurement 79.11 meters was made along series of level stakes about 15 to 19 meters apart.)

Suitable signals were then built to mark the north range, one of them being built adjacent to the stub marking B, the other about 40 meters inshore and on the azimuth line 104° N. 20′ 50″ E. through B, obtained by observing angle at B between distant triangulation and inshore range signal. (The azimuth to the triangulation station having been computed.)

Two signals marking the south range were built on the azimuth line 104° 20′ 50″ through A, the front range being placed on the face of the wharf, about 1 foot away from A and the other range was built on shore near the wharf and about 80 meters from A. It was found impracticable to locate the rear ranges by triangulation, as they were not visible from more than one triangulation station.

The ends of the course were marked by buoys. In order to place a buoy on the course, the angle between range and a certain identified object was taken from the topographic sheet; the desired spot was then obtained by getting on range while sighting the given angle between range and object with a sextant.

It was understood that the buoys and moorings are to be replaced later by larger gear by the naval air station, and in order to relocate them, cross ranges were noted for the north-end buoy and the south-end buoy.

### MARYLAND.

[E. D. BROMLEY.]

Work was undertaken at the request of the War Department for the purpose of determining by triangulation the geographic positions of certain range towers for the Aberdeen Proving Ground from Mulberry Point to Love Point, Kent Island, upper Chesapeake Bay.

In March and April, 1918, several towers had been located by John A. Daniels as far south as Worton Point. These were found inadequate in number and range for the large guns to be tested at the grounds, and the scheme was therefore extended south to Love Point, Kent Island.

First a scheme of towers was selected using both sides of the bay. This scheme was laid out, the necessary clearing done, and signals built. After the observations had been completed, it was decided by the proving-ground officials that the towers on the western shore were dangerous, being in line of fire at certain ranges. It was then decided to place extra towers on the eastern shore and eliminate all proposed locations on the western shore.

With this new scheme in view, all the stations had to be reoccupied and a new list of directions made for each station, including the new ones.

The towers were located back from the shore, usually about 100 meters, and in some cases 400 meters, which necessitated a great amount of clearing for observations of range firing and for measuring the angles of the triangulation.

The towers themselves could not be used in observing the angles for the triangulation, as they were only single towers with four legs, having a house at the top 10 feet square. Most of the towers were not built when the observing was done. In some cases the instrument was set on a special tripod built under the range towers and sometimes on its own tripod set up on the ground over the station mark. The towers are eccentric to the triangulation stations.

There were three regular triangulation stations established.

There were only four old triangulation stations recovered from Love Point, Kent Island, to Turkey Point Lighthouse, Turkey Point, and it was necessary to make a complete scheme of triangulation for the whole of the upper Chesapeake Bay.

The Aberdeen Proving Ground furnished recorders and laborers. One recorder and one helper were used in the triangulation party. Fifteen men and a foreman were engaged in building signals and clearing trees on the western shore and on Pooles Island. On the eastern shore a detail of 12 soldiers and 1 sergeant were employed cutting trees, marking stations, and building signals. The detail camped along in the different places, and rations were furnished them from the proving grounds. Transportation was furnished by the proving-ground authorities in either boat or automobile.

In all there were 42 stations in the scheme, including 7 lighthouses and the 2 range lights on Pooles Island.

The officials of the Aberdeen Proving Ground cooperated in the work in every way possible.

### FLORIDA.

[H. LEYPOLDT.]

In February a conference was had with the commanding officer of the naval air station at Miami, Fla., for the purpose of ascertaining to what extent the method of topographic surveying by airplane would be useful in the work of the U. S. Coast and Geodetic Survey.

The commanding officer of the naval air station was instructed by the Navy Department to cooperate with the party of the Coast and Geodetic Survey at work at Miami, and to render every assistance which would not actually interfere with the military operations of that station.

The methods used in aerial photography were examined and a report made on the subject.

### MARYLAND.

[PAUL M. TRUEBLOOD.]

SUMMARY OF RESULTS.—Triangulation: 132.5 square miles of area covered, 30 signal poles erected, 19 stations in main scheme occupied for horizontal measures, 8 stations in supplemental schemes occupied for horizontal measures, 37 geographic positions determined.

The location of ranges, torpedo firing course, Potomac River, and revision of triangulation, Potomac River, Piney Point to Blackistone Island, are two projects which were executed as one continuous piece of work and both are therefore covered in a single abstract.

The work originally requested by the Navy Department was the establishment of permanent shore ranges for a torpedo firing course in the Potomac River. The firing point was to be defined by ranges intersecting at a point 2,500 yards south of Piney Point Lighthouse. The true bearing of the firing range was 122° from this point (geodetic azimuth 302°). Cross ranges were to be located which would intersect the firing range at 4,000-yard intervals from the firing point up to 20,000 yards. The cross ranges were to intersect the firing range at an angle of approximately 90°, the shore points were to be permanently marked, and they were to be far enough apart to make a "sensitive" range; that is, so that the range marks would open considerably for a slight variation from the exact intersection.

To this was added the revision of triangulation from Piney Point Lighthouse to Blackistone Island, so as to furnish geographic positions, lengths, and azimuths for the firing range from the lower proving grounds.

A number of supplementary points were added to the main scheme, in order to have a sufficient number of observing stations convenient to any part of the river.

Instructions for the field work were issued under date of March 28, and on that day a reconnoissance trip was made to Millers Wharf, Md. At a conference with Capt. Miller it was arranged that a submarine chaser was to be detailed by the Navy and a working party and equipment were to be supplied, while the Survey was to furnish the instruments and any additional labor and materials that might be necessary. The chaser was to be available April 21.

On April 19 the chief of party left for the field. A room for the storage of instruments and for computing was obtained on April 21, and on the 22d the submarine chaser arrived with the working party and equipment.

It was found that most of the old-scheme stations of the triangulation had been lost. It was therefore necessary to lay out a new scheme of simple quadrangles with sufficient points to determine the range stations by intersection. The reconnoissance and signal building were done at the same time, as it was found that the original figures could be followed in a general way.

Most of the observing was done by the chief of party, using the 7-inch Berger theodolite No. 194. Six stations were occupied by Lieut. Simpson Earle. The accuracy of the work as indicated by the triangle closures is very satisfactory.

Valuable assistance was rendered by Lieut. Earle and by the Navy in furnishing a submarine chaser, working party, equipment, and signal-building material. Lieut. Earle assisted in building the signals and marking stations in the lower reach of the river, and did all of this work in the upper reach from Piney Point to Blackistone Island. He also did a considerable amount of observing and assisted in every way possible to keep the work going smoothly.

Respectfully,

E. LESTER JONES,
*Superintendent.*

To Hon. WILLIAM C. REDFIELD,
*Secretary of Commerce.*

# REPORT

OF THE

# SUPERVISING INSPECTOR GENERAL, STEAMBOAT INSPECTION SERVICE

# REPORT

### OF THE

# SUPERVISING INSPECTOR GENERAL

## STEAMBOAT-INSPECTION SERVICE.

DEPARTMENT OF COMMERCE,
STEAMBOAT-INSPECTION SERVICE,
*Washington, August 30, 1919.*

SIR: Herewith is submitted the report of the operations of the Steamboat-Inspection Service for the fiscal year ended June 30, 1919, as required by section 4403, Revised Statutes, and the Department regulations relating thereto.

### ORGANIZATION.

The following positions were embraced in the Steamboat-Inspection Service at the close of business on June 30, 1919:

| | |
|---|---|
| At Washington, D. C.: | |
| Supervising Inspector General | 1 |
| Deputy Supervising Inspector General (who is Acting Supervising Inspector General in the absence of that officer) | 1 |
| Clerks | 10 |
| Messenger | 1 |
| In the Service at large: | |
| Supervising inspectors | 11 |
| Traveling inspectors | 3 |
| Local inspectors of hulls | 48 |
| Local inspectors of boilers | 48 |
| Assistant inspectors of hulls | 82 |
| Assistant inspectors of boilers | 83 |
| Clerks to boards of local inspectors | 97 |
| Total | 385 |

Sixty-four permanent positions were added to the Service during the year, as follows:

One supervising inspector at Seattle, Wash., and one traveling inspector, with headquarters in the office of the Supervising Inspector General.

One clerk in the office of the Supervising Inspector General, Washington, D. C.

The following assistant inspectors: Two assistant inspectors of hulls and three assistant inspectors of boilers—San Francisco, Calif. Two assistant inspectors of hulls and two assistant inspectors of boilers—Cleveland, Ohio. One assistant inspector of hulls and two assistant inspectors of boilers—Philadelphia, Pa.; Seattle, Wash.;

and Portland, Oreg. Two assistant inspectors of hulls and one assistant inspector of boilers—New York, N. Y. One assistant inspector of hulls and one assistant inspector of boilers—Boston, Mass.; Milwaukee, Wis.; Los Angeles, Calif.; New London, Conn.; and Portland, Me. One assistant inspector of hulls—Baltimore, Md.; New Haven, Conn.; and Norfolk, Va. One assistant inspector of boilers—Chicago, Ill.; Jacksonville, Fla.; and Toledo, Ohio.

Twenty-four additional clerks were added to the Service at large.

## SUMMARY OF OFFICE WORK.

Following is a summary of the work of the Office of the Supervising Inspector General for the year ended June 30, 1919:

| | |
|---|---|
| Copies of circular letters issued | 149,355 |
| Copies of Steamboat-Inspection Service bulletins issued | 28,900 |
| Excursion permits reported issued | 87 |
| Permits to use oil as fuel on steamers | 376 |
| Miscellaneous accounts examined and approved | 2,076 |
| Index (card system) correspondence, new numbers | 3,012 |
| Estimated number of letters answered | 28,000 |
| Personal-expense accounts examined and approved | 2,756 |
| Daily reports of inspectors examined and approved | 22,630 |
| Returns of nonexpendable property received, examined, and filed | 64 |
| Returns of expendable property received, examined, and filed | 64 |
| Requisitions for supplies, printed stationery, and blank forms received, examined, and approved | 950 |
| Reports of casualties and violations of law recorded and filed | 2,051 |
| Special reports on casualties prepared and submitted to the Secretary of Commerce | 111 |
| Vessel-inspection cards received, examined, and filed | 31,500 |
| Reports of tests of materials at mills received, recorded, and filed | 2,861 |
| Reports examined of life preservers inspected at factory | 979 |
| License cards received, examined, and filed | 36,000 |
| Reports of absences received, examined, and filed | 636 |
| Reports of circular letters acknowledged, received, examined, and filed | 744 |
| Records of fusible plugs inserted in boilers received, examined, and filed | 9,600 |
| Invoices of supplies, blank forms, and printed stationery received, checked, and forwarded | 4,500 |

## EXPENDITURES.

Following is a detailed account of the expenditures for the year ended June 30, 1919:

| | |
|---|---|
| Salaries, Supervising Inspector General, Deputy Supervising Inspector General, supervising and local inspectors, assistant inspectors, traveling inspectors, and clerks to local boards | $685,707.58 |
| Salaries, clerks, and messenger in the Office of the Supervising Inspector General at Washington, D. C | 14,361.05 |
| Total | 700,068.63 |
| Traveling expenses (actual) | 88,884.06 |
| Rents, offices | 29,825.63 |
| Furniture, instruments, etc., and repairs to same | 11,590.44 |
| Stationery, supplies, and transportation of same | 8,328.84 |
| Telephone rents and telegrams | 4,426.28 |
| Witnesses' fees and mileage in cases of investigation | 646.24 |
| Ice, fuel, and electric light | 579.78 |
| Janitor service | 264.00 |
| Toilet service, laundry, soap, etc | 256.46 |
| Marine publications and official railway guides | 70.00 |

| | |
|---|---|
| Moving offices | $59.60 |
| Miscellaneous | 128.00 |
| Total traveling and miscellaneous expenses | 145,059.33 |
| Salaries as noted above | 700,068.63 |
| Total expenditures for year ended June 30, 1919 | 845,127.96 |
| Total expenditures for year ended June 30, 1918 | 654,880.00 |
| Increase, 1919 | 190,247.96 |
| Salaries, 1919 | 700,068.63 |
| Salaries, 1918 | 534,202.37 |
| Increase, 1919 | 165,866.26 |
| Contingent expenses, 1919 | 145,059.33 |
| Contingent expenses, 1918 | 120,677.63 |
| Increase, 1919 | 24,381.70 |
| Rents, 1919 | 29,825.63 |
| Rents, 1918 | 20,337.49 |
| Increase, 1919 | 9,488.14 |
| Traveling expenses, 1919 | 88,884.06 |
| Traveling expenses, 1918 | 81,273.44 |
| Increase, 1919 | 7,610.62 |

A comparison of the expenditures of the Bureau for the year ended June 30, 1919, with the previous year will show that there were increases in nearly all items of expenditure. The increases in salaries and traveling expenses were due to the appointment of additional inspectors and clerks, the increasing of the salaries of the inspectors, and to the increased rates of transportation. The increase in rents was due to the fact that during the year several of the field offices of the Bureau were moved from Government buildings to private buildings.

## NUMBER, CLASS, AND TONNAGE OF VESSELS INSPECTED.

There is submitted herewith a tabulated statement showing the number, class, and tonnage of vessels regularly inspected by this Service and granted certificates.

## CERTIFICATES OF INSPECTION ISSUED TO STEAM AND MOTOR VESSELS AND TO BARGES DURING THE YEAR ENDED JUNE 30, 1919, BY DISTRICTS.

| Supervising district. | Local district. | Domestic vessels. | | | | | | | | | | Foreign passenger steam vessels. | | Total. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Steam vessels. | | Motor vessels | | Passenger barges. | | Seagoing barges. | | Total. | | | | | |
| | | *Number.* | *Gross tonnage.* | *Number.* | *Gross tonnage.* | *Number.* | *Gross tonnage.* | *Number.* | *Gross tonnage.* | *Number.* | *Gross tonnage.* | *Number.* | *Gros tonnage.* | *Number.* | *Gross tonnage.* |
| First | San Francisco, Calif. | 346 | 676,020 | 86 | 23,876 | 2 | 1,100 | 9 | 17,929 | 443 | 718,925 | 16 | 87,204 | 459 | 806,129 |
| | Honolulu, Hawaii | 19 | 16,477 | 7 | 3,703 | | | 2 | 1,765 | 28 | 21,945 | 9 | 86,174 | 37 | 108,119 |
| | Los Angeles, Calif. | 43 | 157,380 | 9 | 445 | | | 3 | 2,830 | 55 | 160,655 | | | 55 | 160,655 |
| | Portland, Oreg. | 217 | 496,832 | 21 | 7,496 | 1 | 538 | | | 239 | 504,866 | | | 239 | 504,866 |
| Second | New York, N. Y. | 1,161 | 1,353,077 | 82 | 35,146 | 4 | 2,175 | 147 | 140,888 | 1,394 | 1,531,286 | 157 | 1,826,259 | 1,551 | 3,357,545 |
| | Albany, N. Y. | 150 | 71,221 | | | | | 2 | 1,603 | 152 | 72,824 | | | 152 | 72,824 |
| | New Haven, Conn. | 56 | 7,424 | 31 | 1,221 | | | 1 | 455 | 88 | 9,100 | | | 88 | 9,100 |
| | Philadelphia, Pa. | 340 | 673,936 | 49 | 7,338 | | | 45 | 36,094 | 434 | 717,368 | 3 | 31,140 | 437 | 748,508 |
| Third | Norfolk, Va. | 230 | 280,073 | 46 | 1,155 | 2 | 620 | 84 | 62,905 | 362 | 344,753 | 3 | 14,796 | 365 | 359,549 |
| | Baltimore, Md. | 239 | 291,707 | 40 | 1,942 | | | 23 | 16,914 | 302 | 310,563 | | | 302 | 310,563 |
| | Charleston, S. C. | 64 | 14,504 | 10 | 250 | | | 9 | 8,290 | 83 | 23,044 | | | 83 | 23,044 |
| | Jacksonville, Fla. | 45 | 36,285 | 22 | 2,336 | | | 7 | 3,988 | 74 | 42,609 | | | 74 | 42,609 |
| | Savannah, Ga. | 51 | 39,983 | 2 | 56 | | | 3 | 2,056 | 56 | 42,095 | | | 56 | 42,095 |
| Fourth | St. Louis, Mo. | 65 | 11,667 | 17 | 457 | | | | | 82 | 12,124 | | | 82 | 12,124 |
| | Dubuque, Iowa | 29 | 3,959 | 39 | 1,414 | 1 | 263 | | | 69 | 5,636 | | | 69 | 5,636 |
| Fifth | Boston, Mass. | 190 | 186,291 | 3 | 98 | | | 45 | 42,625 | 238 | 229,014 | 5 | 46,051 | 243 | 275,065 |
| | Bangor, Me. | 18 | 1,531 | 13 | 1,065 | | | 11 | 13,488 | 42 | 16,084 | 1 | 363 | 43 | 16,447 |
| | New London, Conn. | 51 | 31,525 | 10 | 539 | | | | | 61 | 32,064 | | | 61 | 32,064 |
| | Portland, Me. | 77 | 90,186 | 10 | 1,207 | | | 18 | 16,370 | 105 | 107,763 | 5 | 47,086 | 110 | 154,849 |
| | Providence, R. I. | 76 | 86,684 | 13 | 445 | | | 40 | 44,753 | 129 | 131,882 | | | 129 | 131,882 |
| Sixth | Louisville, Ky. | 29 | 4,780 | 10 | 667 | | | | | 39 | 5,447 | | | 39 | 5,447 |
| | Evansville, Ind. | 33 | 6,239 | 2 | 104 | | | | | 35 | 6,343 | | | 35 | 6,343 |
| | Memphis, Tenn. | 44 | 5,857 | 5 | 134 | | | | | 49 | 5,991 | | | 49 | 5,991 |
| | Nashville, Tenn. | 49 | 5,734 | 3 | 165 | | | | | 52 | 5,899 | | | 52 | 5,899 |
| Seventh | Pittsburgh, Pa. | 82 | 10,883 | | | | | | | 82 | 10,883 | | | 82 | 10,883 |
| | Cincinnati, Ohio | 26 | 5,758 | | | | | | | 26 | 5,758 | | | 26 | 5,758 |
| | Point Pleasant, W. Va. | 38 | 5,152 | 3 | 83 | | | | | 41 | 5,235 | | | 41 | 5,235 |
| Eighth | Detroit, Mich. | 144 | 255,787 | 8 | 228 | | | | | 152 | 256,015 | 2 | 1,169 | 154 | 257,184 |
| | Chicago, Ill. | 105 | 256,314 | 8 | 470 | | | | | 113 | 256,784 | | | 113 | 256,784 |
| | Duluth, Minn. | 135 | 380,364 | 2 | 55 | | | | | 137 | 380,419 | | | 137 | 380,419 |
| | Grand Haven, Mich. | 45 | 38,256 | 4 | 180 | | | | | 49 | 38,436 | | | 49 | 38,436 |
| | Marquette, Mich. | 32 | 40,685 | 1 | 28 | | | | | 33 | 40,713 | 2 | 312 | 35 | 41,025 |
| | Milwaukee, Wis. | 120 | 212,441 | 10 | 394 | | | | | 130 | 212,835 | | | 130 | 212,835 |
| | Port Huron, Mich. | 58 | 49,937 | | | | | | | 58 | 49,937 | 5 | 16,511 | 63 | 66,448 |
| Ninth | Cleveland, Ohio | 208 | 563,255 | | | | | | | 208 | 563,255 | | | 208 | 563,255 |
| | Buffalo, N. Y. | 307 | 924,241 | 1 | 20 | 1 | 107 | 1 | 1,857 | 310 | 926,225 | 9 | 21,746 | 319 | 947,971 |
| | Burlington, Vt. | 16 | 2,849 | 1 | 40 | | | | | 17 | 2,880 | 1 | 94 | 18 | 2,974 |
| | Oswego, N. Y. | 40 | 13,071 | | | | | | | 40 | 13,071 | 4 | 2,206 | 44 | 15,277 |
| | Toledo, Ohio | 64 | 93,711 | 1 | 23 | | | | | 65 | 93,734 | | | 65 | 93,734 |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tenth | New Orleans, La | 216 | 167,544 | 36 | 12,861 | 5 | 4,877 | 11 | 7,147 | 268 | 192,429 | 9 | 22,828 | 277 | 215,257 |
| | Apalachicola, Fla | 14 | 985 | 1 | 37 | ...... | ........ | 1 | 772 | 16 | 1,794 | ...... | ........ | 16 | 1,794 |
| | Galveston, Tex | 80 | 157,467 | 15 | 18,020 | 1 | 945 | 45 | 29,912 | 147 | 206,344 | ...... | ........ | 147 | 206,344 |
| | Mobile, Ala | 84 | 66,436 | 15 | 4,812 | ...... | ........ | 13 | 7,191 | 112 | 78,439 | ...... | ........ | 112 | 78,439 |
| | San Juan, P. R | 9 | 3,223 | 1 | 490 | ...... | ........ | ...... | ........ | 10 | 3,713 | 14 | 60,120 | 24 | 63,833 |
| | Tampa, Fla. | 21 | 24,067 | 19 | 4,000 | ...... | ........ | ...... | ........ | 40 | 28,067 | ...... | ........ | 40 | 28,067 |
| Eleventh | Seattle, Wash | 351 | 650,994 | 43 | 23,032 | ...... | ........ | 8 | 11,211 | 402 | 685,237 | 25 | 166,503 | 427 | 851,740 |
| | Juneau, Alaska | 41 | 2,374 | 7 | 710 | ...... | ........ | ...... | ........ | 48 | 3,084 | ...... | ........ | 48 | 3,084 |
| | St. Michael, Alaska | 16 | 6,230 | 3 | 105 | ...... | ........ | ...... | ........ | 19 | 6,335 | 3 | 2,633 | 22 | 8,968 |
| | Total, 1919 | 5,880 | 8,490,396 | 709 | 156,847 | 17 | 10,625 | 528 | 471,043 | 7,134 | 9,128,911 | 273 | 2,433,255 | 7,407 | 11,562,166 |
| | Total, 1918 | 5,532 | 6,203,124 | 695 | 153,122 | 18 | 10,270 | 543 | 479,840 | 6,788 | 6,846,356 | 227 | 1,618,340 | 7,015 | 8,464,696 |
| | Increase (+) or decrease (−). | +348 | +2,287,272 | +14 | +3,725 | −1 | +355 | −15 | −8,797 | +346 | +2,282,555 | +46 | +814,915 | +392 | +3,097,470 |

## VESSELS INSPECTED AND OFFICERS LICENSED DURING THE FISCAL YEAR ENDED JUNE 30, 1919, BY GEOGRAPHIC DIVISIONS.

| Geographic divisions. | Domestic vessels. | | | | | | | | | | Foreign passenger steam vessels. | | Total. | | Officers licensed. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Steam vessels. | | Motor vessels. | | Passenger barges. | | Seagoing barges. | | Total. | | | | | | Steam vessels. | Motor vessels. | Sail vessels and barges. | Total. |
| | *Number.* | *Gross tonnage.* | *Number.* | *Gross tonnage.* | *Number.* | *Gross tonnage.* | *Number.* | *Gross tonnage* | *Number.* | *Gross tonnage.* | *Number.* | *Gross tonnage.* | *Number.* | *Gross tonnage.* | *Number.* | *Number.* | *Number.* | *Number.* |
| Pacific coast | 1,033 | 2,006,307 | 176 | 59,367 | 3 | 1,638 | 22 | 33,735 | 1,234 | 2,101,047 | 53 | 342,514 | 1,287 | 2,443,561 | 3,320 | 1,643 | 32 | 4,995 |
| Atlantic coast | 2,748 | 3,164,427 | 331 | 52,798 | 6 | 2,795 | 435 | 390,429 | 3,520 | 3,610,449 | 174 | 1,965,695 | 3,694 | 5,576,144 | 12,069 | 3,625 | 86 | 15,780 |
| Western rivers | 395 | 60,029 | 79 | 3,024 | 1 | 263 | ...... | ........ | 475 | 63,316 | ...... | ........ | 475 | 63,316 | 751 | 770 | 2 | 1,523 |
| Northern lakes | 1,274 | 2,839,911 | 36 | 1,438 | 1 | 107 | 1 | 1,857 | 1,312 | 2,843,313 | 23 | 42,098 | 1,335 | 2,885,411 | 2,325 | 910 | ...... | 3,235 |
| Gulf coast | 430 | 419,722 | 87 | 40,220 | 6 | 5,822 | 70 | 45,022 | 593 | 510,786 | 23 | 82,948 | 616 | 593,734 | 1,608 | 903 | 25 | 2,536 |
| Total, 1919 | 5,880 | 8,490,396 | 709 | 156,847 | 17 | 10,625 | 528 | 471,043 | 7,134 | 9,128,911 | 273 | 2,433,255 | 7,407 | 11,562,166 | 20,073 | 7,851 | 145 | 28,069 |
| Total, 1918 | 5,532 | 6,203,124 | 695 | 153,122 | 18 | 10,270 | 543 | 479,840 | 6,788 | 6,846,356 | 227 | 1,618,340 | 7,015 | 8,464,696 | 23,004 | 9,273 | 181 | 32,458 |
| Increase (+) or decrease (−). | +348 | +2,287,272 | +14 | +3,725 | −1 | +355 | −15 | −8,797 | +346 | +2,282,555 | +46 | +814,915 | +392 | +3,097,470 | −2,931 | −1,422 | −36 | −4,389 |

## MISCELLANEOUS INSPECTIONS.

Following is a statement of steam vessels granted letters of approval of designs of boilers, engines, and other operating machinery inspected under an act of Congress approved June 9, 1910, which vessels are not inspected annually, only one inspection being made for letter of approval; hulls of United States Government vessels inspected; and boilers in or for United States Government steamers and buildings inspected during the year ended June 30, 1919:

| Local inspection district (port). | Steam vessels granted letters of approval. | | Government vessels inspected. | Government boilers inspected. | Local inspection district (port). | Steam vessels granted letters of approval. | | Government vessels inspected. | Government boilers inspected. |
|---|---|---|---|---|---|---|---|---|---|
| | *Number.* | *Gross tonnage.* | | | | *Number.* | *Gross tonnage.* | | |
| San Francisco, Calif | ...... | ...... | 2 | 69 | Chicago, Ill | 2 | 60 | ...... | 74 |
| Honolulu, Hawaii | ...... | ...... | ...... | 23 | Duluth, Minn | ...... | ...... | ...... | 8 |
| Los Angeles, Calif | ...... | ...... | ...... | 7 | Grand Haven, Mich | 3 | 101 | 3 | 94 |
| Portland, Oreg | ...... | ...... | ...... | 36 | Marquette, Mich | 2 | 30 | 1 | 6 |
| New York, N. Y | 3 | 115 | 2 | 93 | Milwaukee, Wis | 3 | 86 | 10 | 91 |
| Philadelphia, Pa | ...... | ...... | ...... | 51 | Cleveland, Ohio | ...... | ...... | 2 | 3 |
| Norfolk, Va | 3 | 91 | ...... | 39 | Buffalo, N. Y | 2 | 50 | ...... | 1 |
| Baltimore, Md | ...... | ...... | ...... | 44 | Oswego, N. Y | ...... | ...... | 1 | 28 |
| Charleston, S. C | ...... | ...... | ...... | 29 | New Orleans, La | ...... | ...... | 11 | 160 |
| Savannah, Ga | ...... | ...... | ...... | 51 | Apalachicola, Fla | ...... | ...... | ...... | 13 |
| St. Louis, Mo | ...... | ...... | 3 | 307 | Galveston, Tex | ...... | ...... | ...... | 11 |
| Dubuque, Iowa | 1 | 10 | ...... | 138 | Mobile, Ala | 3 | 45 | ...... | 125 |
| Boston, Mass | ...... | ...... | ...... | 37 | San Juan, P. R | ...... | ...... | ...... | 1 |
| New London, Conn | ...... | ...... | ...... | 9 | Tampa, Fla | ...... | ...... | ...... | 14 |
| Portland, Me | ...... | ...... | ...... | 27 | Seattle, Wash | 1 | 84 | 4 | 44 |
| Providence, R. I | ...... | ...... | 1 | 20 | Juneau, Alaska | ...... | ...... | ...... | 3 |
| Louisville, Ky | ...... | ...... | ...... | 169 | St. Michael, Alaska | ...... | ...... | ...... | 13 |
| Evansville, Ind | ...... | ...... | ...... | 4 | | | | | |
| Memphis, Tenn | ...... | ...... | 28 | 150 | Total, 1919 | 23 | 672 | 79 | 2,337 |
| Nashville, Tenn | ...... | ...... | 10 | 100 | Total, 1918 | 33 | 978 | 84 | 1,716 |
| Pittsburgh, Pa | ...... | ...... | ...... | 114 | Increase (+) or decrease (−) | −10 | −306 | −5 | +621 |
| Cincinnati, Ohio | ...... | ...... | 1 | 29 | | | | | |
| Point Pleasant, W. Va | ...... | ...... | ...... | 91 | | | | | |
| Detroit, Mich | ...... | ...... | ...... | 11 | | | | | |

## REINSPECTIONS.

Following is a statement of reinspections of passenger and ferry steamers made by boards of local inspectors during the year ended June 30, 1919:

| Local inspection district (port). | Passenger steamers. | Ferry steamers. | Total. | Local inspection district (port). | Passenger steamers. | Ferry steamers. | Total. |
|---|---|---|---|---|---|---|---|
| San Francisco, Calif | ........ | 78 | 78 | Cincinnati, Ohio | 10 | 24 | 34 |
| Los Angeles, Calif | ........ | 5 | 5 | Point Pleasant, W. Va | 11 | 12 | 23 |
| Portland, Oreg | 3 | 10 | 13 | Detroit, Mich | 54 | 46 | 100 |
| New York, N. Y | 351 | 322 | 673 | Chicago, Ill | 32 | ........ | 32 |
| Albany, N. Y | 45 | 34 | 79 | Duluth, Minn | 11 | 14 | 25 |
| New Haven, Conn | 12 | ........ | 12 | Grand Haven, Mich | 54 | 5 | 59 |
| Philadelphia, Pa | 7 | 34 | 41 | Marquette, Mich | 3 | ........ | 3 |
| Norfolk, Va | 56 | 20 | 76 | Milwaukee, Wis | 43 | ........ | 43 |
| Baltimore, Md | 122 | 2 | 124 | Port Huron, Mich | 11 | 3 | 14 |
| Charleston, S. C | 10 | 4 | 14 | Cleveland, Ohio | 11 | ........ | 11 |
| Jacksonville, Fla | 6 | 2 | 8 | Buffalo, N. Y | 23 | 7 | 30 |
| Savannah, Ga | 2 | ........ | 2 | Burlington, Vt | 7 | 7 | 14 |
| St. Louis, Mo | 50 | 17 | 67 | Oswego, N. Y | 14 | ........ | 14 |
| Dubuque, Iowa | 11 | 5 | 16 | Toledo, Ohio | 9 | 3 | 12 |
| Boston, Mass | 10 | 20 | 30 | New Orleans, La | 52 | 65 | 117 |
| Bangor, Me | 7 | 3 | 10 | Mobile, Ala | 1 | ........ | 1 |
| New London, Conn | 40 | 9 | 49 | San Juan, P. R | 12 | 3 | 15 |
| Portland, Me | 17 | 8 | 25 | Tampa, Fla | 3 | ........ | 3 |
| Providence, R. I | 37 | 15 | 52 | Seattle, Wash | 13 | 4 | 17 |
| Louisville, Ky | 12 | 7 | 19 | | | | |
| Evansville, Ind | 18 | 6 | 24 | Total, 1919 | 1,245 | 808 | 2,053 |
| Memphis, Tenn | 16 | 6 | 22 | Total, 1918 | 1,154 | 644 | 1,798 |
| Nashville, Tenn | 33 | ........ | 33 | | | | |
| Pittsburgh, Pa | 6 | 8 | 14 | Increase | 91 | 164 | 255 |

## MARINE-BOILER PLATES TESTED.

Following is a statement of marine-boiler plates tested at the mills by assistant inspectors of this Service, during the year ended June 30, 1919, under act of Congress approved January 22, 1894:

| Inspected by assistant inspector— | Plates rejected because of— | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Spoiled at shears. | Lost in shipping house. | Tensile strength. | Elongation. | Lamination. | Light gauge. | Surface defects. | Excessive plates. |
| J. N. J. Seltzer, Coatesville, Pa | 43 | 189 | 570 | 10 | 37 | 32 | 468 | 19 |
| F. P. Noel, Coatesville, Pa | 31 | 7 | 70 | 6 | 1 | | 93 | 1 |
| Geo. L. Taylor, Coatesville, Pa | | 2 | 2 | | | | | |
| Samuel A. Mills, Philadelphia, Pa | | 5 | 73 | | 1 | 3 | 27 | |
| Roy B. Huston, Pittsburgh, Pa | | | | | | | 2 | |
| Geo. E. Berry, Pittsburgh, Pa | | | | 1 | | | 5 | |
| Harry Layfield, Pittsburgh, Pa | | | 40 | | | 8 | | |
| Otis Richardson, Chicago, Ill | 1 | | 6 | 3 | 27 | 1 | 245 | |
| John T. Farnham, Chicago, Ill | 2 | 1 | 7 | 7 | 10 | 6 | 511 | |
| Walter Greenwood, Chicago, Ill | 1 | 2 | 2 | | 1 | 1 | 19 | |
| C. W. Watson, Cleveland, Ohio | | | | | | | | |
| A. C. Brockner, Cleveland, Ohio | | | 18 | | 27 | | 37 | |
| Roy B. Huston, Cleveland, Ohio | | | | | 9 | 1 | 5 | |
| R. H. Benham, Cleveland, Ohio | | | 3 | | 7 | | 8 | |
| A. Auld, Milwaukee, Wis | | 2 | | | 2 | | 4 | |
| Total, 1919 | 78 | 208 | 791 | 27 | 122 | 52 | 1,424 | 20 |
| Total, 1918 | 13 | 22 | 37 | 11 | 75 | 77 | 194 | 7 |
| Increase (+) or decrease (−) | +65 | +186 | +754 | +16 | +47 | −25 | +1,230 | +13 |

| Inspected by assistant inspector— | Plates rejected because of— | | | | | Total. | | |
|---|---|---|---|---|---|---|---|---|
| | Spoiled in flanging. | Heavy gauge. | Bending test. | No ring marks on plate. | Wrong dimension. | Rejected. | Accepted. | Inspected. |
| J. N. J. Seltzer, Coatesville, Pa | 2 | 7 | 1 | 3 | | 1,381 | 11,115 | 12,496 |
| F. P. Noel, Coatesville, Pa | | | | 1 | | 210 | 2,434 | 2,644 |
| Geo. L. Taylor, Coatesville, Pa | | | | | | 4 | 198 | 202 |
| Samuel A. Mills, Philadelphia, Pa | | | | | | 109 | 2,308 | 2,417 |
| Roy B. Huston, Pittsburgh, Pa | | | | | | 2 | 1,139 | 1,141 |
| Geo. E. Berry, Pittsburgh, Pa | | | | | | 6 | 1,236 | 1,242 |
| Harry Layfield, Pittsburgh, Pa | | | | | | 48 | 1,913 | 1,961 |
| Otis Richardson, Chicago, Ill | | | | | | 283 | 2,270 | 2,553 |
| John T. Farnham, Chicago, Ill | | | | | | 544 | 4,625 | 5,169 |
| Walter Greenwood, Chicago, Ill | | | | | 1 | 27 | 3,229 | 3,256 |
| C. W. Watson, Cleveland, Ohio | | | | | | | 5 | 5 |
| A. C. Brockner, Cleveland, Ohio | | | 1 | | | 83 | 1,010 | 1,093 |
| Roy B. Huston, Cleveland, Ohio | | | | | | 15 | 302 | 317 |
| R. H. Benham, Cleveland, Ohio | | | | | | 18 | 781 | 799 |
| A. Auld, Milwaukee, Wis | | | | | | 8 | 124 | 132 |
| Total, 1919 | 2 | 7 | 2 | 4 | 1 | 2,738 | 32,689 | 35,427 |
| Total, 1918 | | 1 | 13 | 2 | | 452 | 9,153 | 9,605 |
| Increase (+) or decrease (−) | +2 | +6 | −11 | +2 | +1 | +2,286 | +23,536 | +25,822 |

## NEW LIFE PRESERVERS INSPECTED.

During the fiscal year inspectors of this Service inspected new life preservers, as follows:

| Kind. | Passed. | Rejected. | Inspected. |
|---|---|---|---|
| Block cork | 235,744 | 4,345 | 240,089 |
| Tule | 6,862 | ........ | 6,862 |
| Compressed cork | 321 | 4 | 325 |
| Balsa wood (A B C) | 769 | 26 | 795 |
| Ilanasilk | 128,315 | 2,198 | 130,513 |
| Kapok | 55,015 | 1,738 | 56,753 |
| Total, 1919 | 427,026 | 8,311 | 435,337 |
| Total, 1918 | 313,785 | 5,474 | 319,259 |
| Increase | 113,241 | 2,837 | 116,078 |

In addition to the life preservers inspected as shown above, 46,796 cork ring buoys were inspected, 42,495 of which passed and 4,301 were rejected.

## OFFICERS LICENSED.

Following is a statement of officers licensed of all grades, by local districts, during the year ended June 30, 1919:

| Local district. | Masters of steam vessels. | Masters of steam yachts. | Mates of ocean steamers. | Mates of inland steamers. | First-class pilots. | Second-class and special pilots. | Chief engineers. | Assistant engineers. |
|---|---|---|---|---|---|---|---|---|
| San Francisco, Calif | 246 | ........ | 427 | 46 | 24 | 12 | 287 | 573 |
| Honolulu, Hawaii | 13 | ........ | 26 | ........ | ........ | 2 | 10 | 14 |
| Los Angeles, Calif | 24 | ........ | 104 | ........ | ........ | 2 | 27 | 52 |
| Portland, Oreg | 51 | ........ | 74 | 32 | ........ | 8 | 78 | 95 |
| New York, N. Y | 1,118 | ........ | 1,513 | 59 | 204 | 18 | 1,265 | 2,393 |
| Albany, N. Y | 30 | ........ | ........ | 12 | 23 | 17 | 81 | 2 |
| New Haven, Conn | 21 | ........ | 8 | 3 | 16 | 8 | 24 | 5 |
| Philadelphia, Pa | 140 | ........ | 343 | 14 | 32 | 18 | 175 | 327 |
| Norfolk, Va | 132 | ........ | 154 | 1 | 30 | 41 | 147 | 233 |
| Baltimore, Md | 135 | ........ | 258 | 30 | 26 | 34 | 119 | 175 |
| Charleston, S. C | 28 | ........ | 20 | 4 | 7 | 24 | 39 | 47 |
| Jacksonville, Fla | 33 | ........ | 40 | 4 | 5 | 14 | 35 | 42 |
| Savannah, Ga | 31 | ........ | 11 | 7 | 6 | 5 | 26 | 41 |
| St. Louis, Mo | 39 | ........ | ........ | 24 | 30 | 1 | 45 | 14 |
| Dubuque, Iowa | 12 | ........ | ........ | 2 | 10 | 6 | 24 | 19 |
| Boston, Mass | 183 | ........ | 512 | 6 | 26 | 13 | 204 | 450 |
| Bangor, Me | 31 | ........ | 100 | 6 | 8 | 8 | 24 | 6 |
| New London, Conn | 17 | ........ | 2 | ........ | 5 | 6 | 29 | 14 |
| Portland, Me | 68 | 1 | 157 | 4 | 7 | 6 | 58 | 28 |
| Providence, R. I | 34 | ........ | 79 | 5 | 9 | 7 | 45 | 33 |
| Louisville, Ky | 16 | ........ | ........ | 12 | 12 | 2 | 27 | 10 |
| Evansville, Ind | 10 | ........ | 1 | 5 | 13 | 3 | 13 | 5 |
| Memphis, Tenn | 14 | ........ | ........ | 10 | 17 | 1 | 28 | 1 |
| Nashville, Tenn | 13 | ........ | ........ | 13 | 8 | ........ | 20 | 2 |
| Pittsburgh, Pa | 39 | ........ | ........ | 29 | 9 | 5 | 43 | 13 |
| Point Pleasant, W. Va | 13 | ........ | ........ | 22 | 6 | 3 | 18 | 5 |
| Cincinnati, Ohio | 19 | ........ | ........ | 17 | 5 | ........ | 18 | 3 |
| Detroit, Mich | 63 | ........ | 61 | ........ | 42 | 9 | 114 | 75 |
| Chicago, Ill | 38 | ........ | 116 | ........ | 22 | 4 | 83 | 143 |
| Duluth, Minn | 26 | ........ | 1 | ........ | 9 | 7 | 26 | 6 |
| Grand Haven, Mich | 16 | ........ | ........ | ........ | 13 | 11 | 42 | 15 |
| Marquette, Mich | 6 | ........ | ........ | ........ | 5 | 5 | 12 | 1 |
| Milwaukee, Wis | 51 | ........ | ........ | ........ | 73 | 12 | 81 | 109 |
| Port Huron, Mich | 38 | ........ | ........ | ........ | 38 | 5 | 39 | 37 |
| Cleveland, Ohio | 40 | ........ | 66 | 1 | 32 | 3 | 118 | 200 |
| Buffalo, N. Y | 55 | ........ | 2 | ........ | 33 | 27 | 122 | 34 |
| Burlington, Vt | 1 | ........ | ........ | ........ | 1 | 6 | 8 | ........ |
| Oswego, N. Y | 19 | ........ | ........ | ........ | 10 | 10 | 24 | 9 |
| Toledo, Ohio | 13 | ........ | ........ | ........ | 10 | 4 | 22 | 7 |
| New Orleans, La | 187 | ........ | 271 | 16 | 46 | 53 | 191 | 265 |
| Apalachicola, Fla | 14 | ........ | 2 | 4 | 1 | 4 | 5 | 2 |
| Galveston, Tex | 44 | ........ | 53 | 1 | 6 | 10 | 40 | 45 |

| Local deitrict. | Masters of steam vessels. | Masters of steam yachts. | Mates of ocean steamers. | Mates of inland steamers. | First-class pilots. | Second-class and special pilots. | Chief engineers. | Assistant engineers. |
|---|---|---|---|---|---|---|---|---|
| Mobile, Ala | 49 | ........ | 21 | 5 | 10 | 22 | 62 | 22 |
| San Juan, P. R | 5 | ........ | 9 | ........ | 4 | 5 | 6 | 11 |
| Tampa, Fla | 34 | ........ | 25 | 2 | 2 | 3 | 22 | 26 |
| Seattle, Wash | 208 | ........ | 221 | 43 | 1 | 26 | 167 | 378 |
| Juneau, Alaska | 5 | ........ | 1 | 2 | ........ | 8 | 2 | 1 |
| St. Michael, Alaska | 13 | ........ | ........ | 4 | 1 | 1 | 6 | ........ |
| Total, 1919 | 3,435 | 1 | 4,678 | 445 | 897 | 499 | 4,101 | 5,980 |
| Total, 1918 | 5,022 | 3 | 3,756 | 455 | 1,262 | 833 | 7,185 | 4,420 |
| Increase (+) or decrease (−) | −1,587 | −2 | +922 | −10 | −365 | −334 | −3,084 | +1,560 |

| Local district. | Special engineers. | Joint pilots and engineers. | Engineers of motor vessels other than steam. | Operators of motor vessels. | Masters of sail vessels of over 700 gross tons. | Mates of sail vessels of over 700 gross tons. | Masters of barges of over 100 gross tons. | Total of all grades. |
|---|---|---|---|---|---|---|---|---|
| San Francisco, Calif | ........ | ........ | 136 | 361 | 20 | 5 | ........ | 2,137 |
| Honolulu, Hawaii | ........ | ........ | 13 | 20 | ........ | ........ | ........ | 98 |
| Los Angeles, Calif | ........ | ........ | 23 | 184 | 1 | ........ | ........ | 417 |
| Portland, Oreg | 2 | ........ | 22 | 238 | 2 | ........ | ........ | 602 |
| New York, N. Y | ........ | ........ | 149 | 654 | 48 | 5 | 2 | 7,428 |
| Albany, N. Y | ........ | ........ | 1 | 46 | ........ | ........ | ........ | 212 |
| New Haven, Conn | ........ | ........ | 16 | 89 | 2 | ........ | ........ | 192 |
| Philadelphia, Pa | ........ | 1 | 32 | 457 | 4 | ........ | ........ | 1,543 |
| Norfolk, Va | 5 | 3 | 35 | 443 | 1 | ........ | ........ | 1,225 |
| Baltimore, Md | ........ | ........ | 34 | 320 | ........ | ........ | ........ | 1,131 |
| Charleston, S. C | ........ | 3 | 11 | 109 | ........ | ........ | ........ | 292 |
| Jacksonville, Fla | 1 | ........ | 28 | 269 | 3 | ........ | ........ | 474 |
| Savannah, Ga | ........ | ........ | 13 | 59 | 1 | ........ | ........ | 200 |
| St. Louis, Mo | 1 | 1 | 6 | 170 | ........ | ........ | ........ | 331 |
| Dubuque, Iowa | ........ | ........ | 16 | 108 | ........ | ........ | 2 | 190 |
| Boston, Mass | ........ | ........ | 34 | 245 | 8 | 1 | ........ | 1,682 |
| Bangor, Me | 1 | ........ | 12 | 127 | 7 | ........ | ........ | 330 |
| New London, Conn | 1 | ........ | 28 | 129 | ........ | ........ | ........ | 231 |
| Portland, Me | ........ | ........ | 9 | 142 | 2 | ........ | ........ | 492 |
| Providence, R. I | ........ | ........ | 13 | 121 | 2 | ........ | ........ | 348 |
| Louisville, Ky | 3 | ........ | 8 | 61 | ........ | ........ | ........ | 151 |
| Evansville, Ind | 1 | ........ | 7 | 80 | ........ | ........ | ........ | 188 |
| Memphis, Tenn | ........ | ........ | 1 | 94 | ........ | ........ | ........ | 166 |
| Nashville, Tenn | ........ | ........ | 5 | 59 | ........ | ........ | ........ | 120 |
| Pittsburgh, Pa | 5 | ........ | 3 | 54 | ........ | ........ | ........ | 200 |
| Point Pleasant, W. Va | ........ | ........ | 6 | 55 | ........ | ........ | ........ | 128 |
| Cincinnati, Ohio | ........ | ........ | 5 | 32 | ........ | ........ | ........ | 99 |
| Detroit, Mich | ........ | ........ | 5 | 57 | ........ | ........ | ........ | 426 |
| Chicago, Ill | ........ | ........ | 11 | 117 | ........ | ........ | ........ | 534 |
| Duluth, Minn | 1 | ........ | 1 | 32 | ........ | ........ | ........ | 109 |
| Grand Haven, Mich | 1 | ........ | 4 | 144 | ........ | ........ | ........ | 246 |
| Marquette, Mich | 1 | ........ | 2 | 65 | ........ | ........ | ........ | 97 |
| Milwaukee, Wis | ........ | ........ | 9 | 65 | ........ | ........ | ........ | 391 |
| Port Huron, Mich | ........ | ........ | ........ | 26 | ........ | ........ | ........ | 183 |
| Cleveland, Ohio | ........ | ........ | 10 | 44 | ........ | ........ | ........ | 514 |
| Buffalo, N. Y | ........ | ........ | 5 | 103 | ........ | ........ | ........ | 381 |
| Burlington, Vt | ........ | ........ | 1 | 23 | ........ | ........ | ........ | 40 |
| Oswego, N. Y | ........ | ........ | 1 | 113 | ........ | ........ | ........ | 186 |
| Toledo, Ohio | ........ | ........ | 3 | 69 | ........ | ........ | ........ | 128 |
| New Orleans, La | 1 | ........ | 96 | 169 | 11 | ........ | 1 | 1,307 |
| Apalachicola, Fla | ........ | ........ | 3 | 71 | ........ | ........ | ........ | 106 |
| Galveston, Tex | 1 | ........ | 37 | 145 | ........ | 1 | ........ | 383 |
| Mobile, Ala | 1 | ........ | 19 | 102 | 7 | ........ | ........ | 320 |
| San Juan, P. R | ........ | ........ | 7 | 25 | 1 | ........ | ........ | 73 |
| Tampa, Fla | ........ | ........ | 38 | 191 | 3 | 1 | ........ | 347 |
| Seattle, Wash | 1 | 2 | 109 | 379 | 3 | 1 | ........ | 1,539 |
| Juneau, Alaska | ........ | ........ | 6 | 92 | ........ | ........ | ........ | 117 |
| St. Michael, Alaska | ........ | ........ | 3 | 57 | ........ | ........ | ........ | 85 |
| Total, 1919 | 27 | 10 | 1,036 | 6,815 | 126 | 14 | 5 | 28,069 |
| Total, 1918 | 55 | 13 | 1,138 | 8,135 | 162 | 12 | 7 | 32,458 |
| Increase (+) or decrease (−) | −28 | −3 | −102 | −1,320 | −36 | +2 | −2 | −4,389 |

## EXAMINATIONS FOR COLOR BLINDNESS.

During the year ended June 30, 1919, 9,753 applicants for original licenses and for renewals of licenses were examined for visual defects, 108 of whom were found color blind, or had other visual defects, and were rejected and 9,645 were passed. As compared with the previous year, these figures show a decrease of 1,962 in the number examined and 1,864 in the number passed.

## CERTIFICATES OF SERVICE ISSUED TO ABLE SEAMEN.

There is submitted herewith a tabulated statement showing the number of applications received for certificates of service as able seamen, the number of applicants rejected, and the number of certificates issued during the year ended June 30, 1919:

| Local inspection district. | Applications received. | Applications rejected. | Certificates issued. | Local inspection district. | Applications received. | Applications rejected. | Certificates issued. |
|---|---|---|---|---|---|---|---|
| San Francisco, Calif | 122 | 4 | 118 | Marquette, Mich | 82 | 6 | 76 |
| Los Angeles, Calif | 13 | ........ | 13 | Milwaukee, Wis | 183 | 34 | 149 |
| Honolulu, Hawaii | 9 | 2 | 7 | Port Huron, Mich | 60 | 10 | 50 |
| Portland, Oreg | 171 | 4 | 167 | Cleveland, Ohio | 554 | 59 | 495 |
| New York, N. Y | 3,008 | 206 | 2,802 | Buffalo, N. Y | 410 | 53 | 357 |
| New Haven, Conn | 8 | 2 | 6 | Oswego, N. Y | 19 | 1 | 18 |
| Philadelphia, Pa | 667 | 51 | 616 | Toledo, Ohio | 120 | 8 | 112 |
| Norfolk, Va | 456 | 25 | 431 | New Orleans, La | 141 | 6 | 135 |
| Baltimore, Md | 457 | 37 | 420 | Apalachicola, Fla | 5 | ........ | 5 |
| Charleston, S. C | 8 | ........ | 8 | Galveston, Tex | 48 | 8 | 40 |
| Jacksonville, Fla | 151 | 13 | 138 | Mobile, Ala | 160 | 11 | 149 |
| Savannah, Ga | 568 | 26 | 542 | San Juan, P. R | 62 | 3 | 59 |
| Boston, Mass | 381 | 14 | 367 | Tampa, Fla | 181 | 2 | 179 |
| Bangor, Me | 9 | ........ | 9 | Seattle, Wash | 606 | 88 | 518 |
| New London, Conn | 11 | 1 | 10 | Juneau, Alaska | 3 | ........ | 3 |
| Portland, Me | 60 | ........ | 60 | | | | |
| Providence, R. I | 98 | 2 | 96 | Total, 1919 | 9,556 | 760 | 8,796 |
| Detroit, Mich | 287 | 42 | 245 | Total, 1918 | 8,934 | 600 | 8,334 |
| Chicago, Ill | 222 | 9 | 213 | | | | |
| Duluth, Minn | 238 | 27 | 211 | Increase | 622 | 160 | 436 |
| Grand Haven, Mich | 28 | 6 | 22 | | | | |

## CERTIFICATES OF EFFICIENCY ISSUED TO LIFEBOAT MEN.

The following statement shows the number of applications received for certificates of efficiency as lifeboat men, the number of applicants rejected, and the number of certificates issued during the year ended June 30, 1919:

| By whom issued, port, vessel, etc. | Applications received. | Applications rejected. | Certificates issued. |
|---|---|---|---|
| Local inspectors of steam vessels: | | | |
| San Francisco, Calif. | 9 | | 9 |
| Honolulu, Hawaii | 1 | | 1 |
| Portland, Oreg. | 139 | | 139 |
| Los Angeles, Calif. | 66 | | 66 |
| New York, N. Y | 2 | | 2 |
| New Haven, Conn | 44 | | 44 |
| Philadelphia, Pa | 3 | | 3 |
| Norfolk, Va | 128 | | 128 |
| Baltimore, Md | 314 | | 314 |
| Charleston, W. Va | 8 | | 8 |
| Jacksonville, Fla | 167 | | 167 |
| Savannah, Ga. | 101 | | 101 |
| Boston, Mass | 257 | | 257 |
| Bangor, Me | 6 | | 6 |
| New London, Conn | 120 | | 120 |
| Providence, R. I | 122 | | 122 |
| Detroit, Mich | 279 | | 279 |
| Chicago, Ill | 3 | | 3 |
| Duluth, Minn | 5 | | 5 |
| Grand Haven, Mich | 85 | | 85 |
| Marquette, Mich | 1 | | 1 |
| Milwaukee, Wis | 2 | | 2 |
| Port Huron, Mich | 2 | | 2 |
| Cleveland, Ohio | 180 | 37 | 143 |
| Buffalo, N. Y | 50 | | 50 |
| Oswego, N. Y | 2 | | 2 |
| Toledo, Ohio | 3 | | 3 |
| Burlington, Vt | 16 | | 16 |
| New Orleans, La | 85 | | 85 |
| Galveston, Tex | 20 | | 20 |
| Mobile, Ala | 35 | | 35 |
| San Juan, P. R | 4 | | 4 |
| Tampa, Fla | 33 | | 33 |
| Seattle, Wash | 288 | 2 | 286 |
| Juneau, Alaska | 13 | | 13 |
| U. S. Coast and Geodetic Survey, Department of Commerce: | | | |
| Steamers— | | | |
| Explorer | 4 | | 4 |
| Isis | 10 | 3 | 7 |
| Bureau of Lighthouses, Department of Commerce. | | | |
| Lighthouse District— | | | |
| No. 1 | 18 | | 18 |
| No. 2 | 28 | 3 | 25 |
| No. 3 | 22 | 1 | 21 |
| No. 4 | 1 | | 1 |
| No. 5 | 7 | | 7 |
| No. 6 | 2 | | 2 |
| No. 8 | 14 | 11 | 3 |
| No. 9 | 85 | 65 | 20 |
| No. 10 | 1 | | 1 |
| Bureau of Lighthouses, Department of Commerce—Continued. | | | |
| No. 11 | 20 | 8 | 12 |
| No. 12 | 7 | | 7 |
| No. 16 | 1 | | 1 |
| No. 17 | 56 | | 56 |
| No. 18 | 24 | 3 | 21 |
| No. 19 | 6 | 1 | 5 |
| U. S. Coast Guard, Navy Department: | | | |
| Cutters— | | | |
| Androscoggin | 5 | | 5 |
| Arcata | 10 | 3 | 7 |
| Comanche | 11 | | 11 |
| Ossipee | 1 | | 1 |
| Sault Ste. Marie | 3 | | 3 |
| Scout | 1 | | 1 |
| Stations— | | | |
| No. 221 | 3 | | 3 |
| No. 235 | 138 | 45 | 93 |
| No. 237 | 38 | | 38 |
| No. 238 | 18 | | 18 |
| No. 239 | 110 | 34 | 76 |
| No. 247 | 5 | | 5 |
| No. 263 | 1 | | 1 |
| No. 274 | 3 | 3 | |
| No. 278 | 54 | 14 | 40 |
| No. 279 | 16 | 5 | 11 |
| No. 280 | 70 | 15 | 55 |
| No. 285 | 3 | | 3 |
| No. 297 | 5 | 2 | 3 |
| No. 304 | 18 | 5 | 13 |
| Navy Department: | | | |
| Navy yards at— | | | |
| New York, N. Y | 703 | 77 | 626 |
| Norfolk, Va | 120 | 7 | 113 |
| Receiving ship at Philadelphia, Pa | 1 | | 1 |
| Naval station at New Orleans, La | 18 | | 18 |
| SUMMARY. | | | |
| Local inspectors of steam vessels | 2,593 | 39 | 2,554 |
| U. S. Coast and Geodetic Survey | 14 | 3 | 11 |
| Bureau of Lighthouses | 292 | 92 | 200 |
| Navy Department | 842 | 84 | 758 |
| U. S. Coast Guard | 513 | 126 | 387 |
| Total, 1919 | 4,254 | 344 | 3,910 |
| Total, 1918 | 5,887 | 786 | 5,101 |
| Decrease | 1,633 | 442 | 1,191 |

## RECORD OF REPORTS OF CASUALTIES AND VIOLATIONS OF LAW.

Following is a statement showing the number of reports covering casualties and violations of law by vessels subject to inspection during the year ended June 30, 1919, by supervising inspection districts:

| Description. | 1st. | 2d. | 3d. | 4th. | 5th. | 6th. | 7th. | 8th. | 9th. | 10th. | 11th. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fire | 10 | 23 | 12 | 3 | 9 | 4 | 1 | 5 | 2 | 11 | ...... | 80 |
| Collision | 23 | 125 | 59 | ...... | 39 | 4 | 3 | 48 | 56 | 16 | 14 | 387 |
| Explosion or accidental escape of steam | 2 | 8 | 1 | ...... | ...... | ...... | ...... | 1 | 1 | 3 | 1 | 17 |
| Wrecked | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 1 | ...... | 1 |
| Grounding | 14 | 27 | 12 | 1 | 25 | 2 | ...... | 26 | 11 | 13 | 8 | 139 |
| Foundered in storm | 2 | 2 | 3 | ...... | ...... | 1 | ...... | 3 | 6 | 3 | 1 | 21 |
| Sinking | 5 | 32 | 4 | 6 | 7 | 6 | 2 | 3 | 6 | 7 | 2 | 80 |
| Accidental drowning | 10 | 15 | 10 | 1 | 15 | 4 | 7 | 5 | 9 | 13 | 3 | 92 |
| Suicide | 7 | 10 | 2 | ...... | 1 | ...... | ...... | 4 | ...... | ...... | 3 | 27 |
| Miscellaneous | 62 | 27 | 20 | 2 | 12 | 21 | 16 | 40 | 21 | 22 | 13 | 256 |
| Violations of law | 112 | 128 | 156 | 4 | 66 | 20 | 4 | 13 | 319 | 127 | 2 | 951 |
| Total, 1919 | 247 | 397 | 279 | 17 | 174 | 62 | 33 | 148 | 431 | 216 | 47 | 2,051 |
| Total, 1918 | 189 | 454 | 168 | 24 | 141 | 114 | 80 | 217 | 286 | 194 | ...... | 1,867 |
| Increase (+) or decrease (−) | +58 | −57 | +111 | −7 | +33 | −52 | −47 | −69 | +145 | +22 | +47 | +184 |

## LIVES LOST ON VESSELS SUBJECT TO INSPECTION.

The statement following shows the loss of life on vessels subject to inspection during the year ended June 30, 1919, divided as to passengers and crew, passenger and nonpassenger steamers, by supervising-inspection districts and by causes:

| Cause. | 1st. | | 2d. | | 3d. | | 4th. | | 5th. | | 6th. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Passengers. | Crew. | Passengers. | Crew. | Passengers. | Crew. | Passengers. | Crew. | Passengers. | Crew. | Passengers. | Crew. |
| **Fire:** | | | | | | | | | | | | |
| Passenger steamers | ...... | ...... | 1 | ...... | 5 | 1 | ...... | ...... | ...... | ...... | ...... | ...... |
| Nonpassenger steamers | ...... | 27 | ...... | 1 | ...... | 1 | ...... | ...... | ...... | 6 | ...... | ...... |
| **Collision:** | | | | | | | | | | | | |
| Passenger steamers | ...... | ...... | ...... | 6 | ...... | 1 | ...... | ...... | ...... | 1 | ...... | ...... |
| Nonpassenger steamers | ...... | 1 | ...... | 34 | ...... | 1 | ...... | ...... | ...... | ...... | ...... | ...... |
| **Explosions, escape of steam, etc.:** | | | | | | | | | | | | |
| Passenger steamers | ...... | ...... | 4 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| Nonpassenger steamers | ...... | 2 | ...... | 10 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| **Foundered in storm:** Nonpassenger steamers | ...... | 10 | ...... | 5 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| **Sinking:** | | | | | | | | | | | | |
| Passenger steamers | ...... | ...... | ...... | 10 | 1 | ...... | 88 | ...... | ...... | ...... | ...... | ...... |
| Nonpassenger steamers | ...... | ...... | 64 | 44 | ...... | ...... | ...... | ...... | ...... | 8 | ...... | ...... |
| **Accidental drowning:** | | | | | | | | | | | | |
| Passenger steamers | ...... | 5 | 3 | 4 | 2 | 4 | ...... | ...... | 7 | 2 | 5 | ...... |
| Nonpassenger steamers | ...... | 6 | ...... | 17 | ...... | 4 | ...... | 1 | ...... | 7 | ...... | 3 |
| **Suicides:** | | | | | | | | | | | | |
| Passenger steamers | 4 | 1 | 6 | 1 | 1 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| Nonpassenger steamers | ...... | 2 | ...... | 3 | ...... | 1 | ...... | ...... | ...... | 1 | ...... | ...... |
| **Miscellaneous:** | | | | | | | | | | | | |
| Passenger steamers | ...... | ...... | ...... | 1 | ...... | 1 | ...... | ...... | ...... | 1 | ...... | ...... |
| Nonpassenger steamers | ...... | 5 | ...... | 3 | ...... | 1 | ...... | ...... | ...... | ...... | ...... | ...... |
| Total— | | | | | | | | | | | | |
| Passenger steamers | 4 | 6 | 14 | 22 | 9 | 7 | 88 | ...... | 7 | 4 | 5 | ...... |
| Nonpassenger steamers | ...... | 53 | 64 | 117 | ...... | 8 | ...... | 1 | ...... | 22 | ...... | 3 |
| Grand total | 4 | 59 | 78 | 139 | 9 | 15 | 88 | 1 | 7 | 26 | 5 | 3 |
| Last year | 10 | 27 | 52 | 244 | 1 | 29 | 2 | 3 | 1 | 26 | 1 | 8 |
| Increase (+) or decrease (−) | −6 | +32 | +26 | −105 | +8 | −14 | +86 | −2 | +6 | ...... | +4 | −5 |

| Cause. | 7th. | | 8th. | | 9th. | | 10th. | | 11th. | | Total. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Passengers. | Crew. | Passengers. | Crew. | Passengers. | Crew. | Passengers. | Crew. | Passengers. | Crew. | Passengers. | Crew. |
| Fire: | | | | | | | | | | | | |
| Passenger steamers | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 6 | 1 |
| Nonpassenger steamers | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 3 | ..... | ..... | ..... | 38 |
| Collision: | | | | | | | | | | | | |
| Passenger steamers | ..... | ..... | ..... | ..... | ..... | ..... | 1 | ..... | ..... | ..... | 1 | 8 |
| Nonpassenger steamers | ..... | ..... | ..... | ..... | ..... | 1 | ..... | ..... | ..... | 1 | ..... | 38 |
| Explosions, escape of steam, etc.: | | | | | | | | | | | | |
| Passenger steamers | ..... | ..... | ..... | 4 | ..... | ..... | ..... | ..... | ..... | ..... | 4 | 4 |
| Nonpassenger steamers | ..... | ..... | ..... | ..... | ..... | 1 | ..... | ..... | ..... | ..... | ..... | 13 |
| Wreck: Nonpassenger steamer | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 1 | ..... | ..... | ..... | 1 |
| Foundered in storm: Nonpassenger steamers | ..... | ..... | ..... | ..... | ..... | 18 | ..... | ..... | ..... | ..... | ..... | 33 |
| Sinking: | | | | | | | | | | | | |
| Passenger steamers | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 89 | 10 |
| Nonpassenger steamers | ..... | ..... | ..... | 2 | ..... | 3 | ..... | ..... | ..... | 6 | 64 | 63 |
| Accidental drowning: | | | | | | | | | | | | |
| Passenger steamers | 1 | 3 | ..... | 1 | 1 | 1 | 3 | 1 | ..... | 1 | 22 | 22 |
| Nonpassenger steamers | ..... | 5 | ..... | 4 | ..... | 7 | ..... | 10 | ..... | 7 | ..... | 71 |
| Suicide: | | | | | | | | | | | | |
| Passenger steamers | ..... | ..... | 2 | 1 | ..... | ..... | ..... | ..... | 2 | ..... | 15 | 3 |
| Nonpassenger steamers | ..... | ..... | ..... | 1 | ..... | ..... | ..... | ..... | ..... | 1 | ..... | 9 |
| Miscellaneous: | | | | | | | | | | | | |
| Passenger steamers | 1 | 1 | ..... | ..... | ..... | ..... | ..... | 1 | ..... | 1 | 1 | 6 |
| Nonpassenger steamers | ..... | ..... | ..... | 5 | ..... | 2 | ..... | 5 | ..... | ..... | ..... | 21 |
| Total— | | | | | | | | | | | | |
| Passenger steamers | 2 | 4 | 2 | 6 | 1 | 1 | 4 | 2 | 2 | 2 | 138 | 54 |
| Nonpassenger steamers | ..... | 5 | ..... | 12 | ..... | 32 | ..... | 19 | ..... | 15 | 64 | 287 |
| Grand total | 2 | 9 | 2 | 18 | 1 | 33 | 4 | 21 | 2 | 17 | 202 | 341 |
| Last year | ..... | 7 | 3 | 29 | 2 | 19 | 5 | 31 | ..... | ..... | 77 | 423 |
| Increase(+)or decrease(−) | +2 | +2 | −1 | −11 | −1 | +14 | −1 | −10 | +2 | +17 | +125 | −82 |

## LIVES SAVED.

During the year the number of lives directly saved by means of the life-saving appliances required by law was 2,349.

## ACCIDENTS RESULTING IN LOSS OF LIFE.

The total number of accidents resulting in loss of life during the past year was 194, a decrease of 23 from the previous year. Enumerated by supervising inspection districts, accidents occurred as follows: First, 27; second, 54; third, 16; fourth, 3; fifth, 18; sixth, 5; seventh, 9; eighth, 16; ninth, 17; tenth, 20; eleventh, 9.

The following disasters resulted in an unusually large loss of life:

On July 5, 1918, at midnight, excursion steamer *Columbia,* while descending the Illinois River, hit right-hand bank opposite Wesley City, Ill., with the result that the steamer sank, causing the loss of 87 lives.

On July 8, 1918, the main pipe and one gate valve between forward starboard boiler and after starboard boiler, on the steamer *Ann Arbor No. 5,* gave way, killing three men instantly and injuring a fourth so that he afterwards died.

On July 31, 1918, at 10.20 p. m., the steamer *Poseidon,* proceeding from Boston, Mass., to Norfolk, Va., collided with the steamer *Somerset,* near Five Fathom Bank Lightship, causing the steamer *Poseidon* to sink and resulting in the loss of five lives.

On August 3, 1918, at 3.20 p. m., the steamer *Berwind*, an Army transport, while en route from Nantes to Brest, France, was torpedoed by a submarine, with the result that the vessel sank, causing the loss of four of the crew.

On August 13, 1918, about 5.10 p. m., the steamer *Frederic R. Kellogg*, when about 12 miles north of Barnegat Light and 5 miles offshore, was struck by a torpedo, which resulted in the sinking of the vessel in 15 seconds. Seven of the crew lost their lives.

On August 31, 1918, about 10.30 a. m., while towing steamer *Glen Cove* was landing near Clymer Street, Wallabout Canal, Brooklyn, N. Y., the boiler exploded, killing the engineer instantly and injuring the captain, cook, and fireman so severely that they afterwards died.

On September 3, 1918, about 2.04 a. m., the U. S. C. T. *Lake Owens* was sunk by an enemy vessel off the coast of Cornwall, England. Five members of the crew were killed and 10 injured.

On September 6, 1918, about 1.45 a. m., in latitude 39° 20′ N., longitude 74° 13′ W., the steamer *Almirante* was sunk as a result of a collision with the steamer *Hisko*. Six members of the crew were lost.

On September 21, 1918, about 5.15 p. m., on trip of the steamer *Julia Safford* from Shooter Island to Thirty-ninth Street, Brooklyn, N. Y., with 271 shipyard employees on board, the feed pipe was forced out of the flange at the boiler, allowing steam and water to escape, and resulting in the scalding of 13 persons, 2 of whom died, and 2 persons got overboard and were drowned.

On October 3, 1918, at 11.20 p. m., the steamer *Lake City*, while on a voyage from Tampa, Fla., to Baltimore, Md., collided with the steamer *James McGee*, proceeding from New York, N. Y., to Mexico, about 5 miles southeast of American Shoal Lighthouse, causing the *Lake City* to sink in about two minutes. The master and 29 others of the crew were lost.

On October 4, 1918, about 12.45 a. m., the steamer *San Saba* was struck by a mine or torpedo while on a trip from New York to Tampa, Fla., and Mobile, Ala., about 10 miles off Barnegat Buoy, breaking in two and sinking immediately. Thirty of the crew were lost.

On October 16, 1918, at 5.20 p. m., when the steamer *Dumaru* was 22 miles west of the island of Guam, she was struck by lightning, from which she caught fire and became a total loss. Nineteen of the crew lost their lives.

On October 20, 1918, about 5 p. m., the freight vessel *Yenrut*, en route from Salt Key to Philadelphia, Pa., foundered during a severe gale in latitude 25° N., longitude 72° 15′ W., resulting in five of the crew losing their lives.

On November 3, 1918, the steamer *Mineola* caught fire while lying in dock at Bar Harbor, Me. Four of the crew, who were sleeping in the forecastle and remained behind to dress, were suffocated by smoke.

On December 3, 1918, the forward section of the steamer *Manola* (having been previously cut into two sections to permit the passage of same through the Welland Canal), in tow of the steamer *Michigan*, foundered during a heavy snowstorm on Lake Ontario, when about 5 miles south of Duck Island. The captain and entire crew of 10 men were lost.

On December 3, 1918, while en route from San Francisco, Calif., to the Philippine Islands, via Honolulu, the steamer *Benito Juarez*, loaded with cargo of explosives, foundered at sea during a northeast gale, in latitude 21° 36′ N., longitude 156° 11′ W., causing the loss of nine of the crew.

On December 24, 1918, when about 260 miles from Chatham Island, the American bark *Aryan* took fire and burned. The crew left the ship in lifeboats, and eight were lost.

On January 4, 1919, the motor vessel *Amazon* capsized while en route from Seattle, Wash., to Tacoma, Wash., when about 2 miles south of Point Robinson. Six of the crew were lost.

On January 11, 1919, the steamer *Castalia* foundered off Cape Sable in the Atlantic Ocean. Forty-two members of the crew were saved by the Norwegian steamer *Bergenfjord*. One man was drowned and four died from exposure.

On January 11, 1919, the steamer *Yuna*, while en route from San Domingo to New York, via Turks Island, struck a reef on the west end of the Mouchoir Banks, and was totally destroyed. Sixty-four persons lost their lives.

On January 12, 1919, while ferrying a part of the crew of the steamer *Sprague* from the steamer to the city of Cairo, Ill., in a yawl in tow of a motor boat, four men were drowned.

On February 8, 1919, the *Uwanta*, fishing tender of the Pacific American Fisheries, while on a trip from Eliza Island to South Bellingham, Wash., waters of Puget Sound, was hit by a heavy squall about 4.30 p. m., resulting in the loss of six persons.

On April 28, 1919, while the steamer *Centralia* was anchored in 7 fathoms of water at Minizo, Mexico, the second mate, purser, wireless operator, and three seamen attempted to go on shore. The boat capsized, and four of the men were drowned.

On May 14, 1919, the steamer *Triton* left Cape Cod Canal with barges *Oxford* and *Nay Aug* for Portland, and the *Nanticoke* for Rockland, Me. On the morning of the 15th about 2 a. m., about 3 miles south-southwest off Isles of Shoals, wind strong northeast, the barge *Nanticoke* suddenly sank. The captain and one man landed in their boat at Rye Beach, and reported the loss of the engineer and the captain's wife and four children.

On May 24, 1919, about 1 o'clock a. m., the passenger steamer *Virginia* caught fire and was totally destroyed. At the time of the accident the steamer was bound for Norfolk, Va., from Baltimore, Md., in the vicinity of Smiths Point Lighthouse. Six persons lost their lives.

### PASSENGERS CARRIED.

During the fiscal year 323,317,657 passengers were carried on steam vessels that are required by law to report the number of passengers carried. Dividing this number by 202, the total number of passengers lost, shows that 1,600,582 passengers were carried for each passenger lost. The total number of lives lost from all causes, passengers and crew, was 543.

## RECONSTRUCTION.

The war with Germany has been won by military victory. That statement may be debated by Germans, or by those who were allied with the central powers, but the fact remains that, as the result of the morale of the armies of the allies and of their unbounded resources, especially of the United States, a military victory has been obtained. The effect, however, of the tremendous preparation on the part of this country in the prosecution of the war with Germany has been to profoundly change the whole economic structure of our civilization. We discovered in this war that there were some things we did not understand and which could have been done in a better way; that there were some processes which were expensive and that there was considerable waste, and, for the first time in the history of our Nation, it was necessary for us to stop to take account of the methods we proposed, to the end that we might improve them. The impulse we then had was the determination to defeat the common enemy, but we find, now that the war has been won, that there will be a greater battle in the time of peace. Bearing this in mind and having especially before us the idea that in the approaching commercial contest between the civilized nations of the world transportation is to be the great factor, this Service must have no small part in the efficiency of that transportation, so far as it affects ships. Having this thought in mind, therefore, there will be briefly discussed certain important matters which it is believed should have attention now, to the end that this Service may function more efficiently, and thereby materially assist in the rehabilitation of the American merchant marine.

### CENTRALIZATION OF APPROVAL OF HULL AND BOILER CONSTRUCTION.

Immediately after the *Eastland* disaster considerable attention was given to the proposition of hull inspection, but more especially with reference to hull construction, and the theory so wisely advanced was consistent with the suggestion which had previously been made in an Annual Report of the Supervising Inspector General of the desirability of the creation of a board of naval architects, in the office of the Supervising Inspector General, whose function it would be to pass upon hull construction. The remedy, however, incident to the *Eastland* disaster was really narrowed down to the proposition of confidently assuring that ships should in future have the proper stability of structure. The necessity still exists for the creation of a board of naval architects with that purpose in view, but there is a broader and really more essential reason why a board should be created, and that is that the whole matter of hull construction should be uniformly approved in the Office of the Supervising Inspector General. If we should say that nothing has been learned from the war which would indicate that there could be any improvement made in this Service, and if the Service, as in the case of an individual, is to be considered as being absolutely perfect, it seems only reasonable to suppose that its usefulness is at an end; for then dry rot has set in. It has been observed, however, that there may be some improvements made in this Service, and especially with reference to the proposition of the approval of hull construction. If a corps of experts were created, the procedure would be something after this manner: When a person proposed to build a vessel, he would be required to submit to the Office of the Supervising Inspector General blue prints descriptive of his proposed hull construction and showing such data and information as would be necessary to enable naval architects to pass intelligently upon the subject. When these blue prints were approved, they would be referred to the respective boards of local inspectors in whose district the vessel or vessels were to be built, and the local inspectors would be required simply to see that the vessels were built as set forth in the blue prints. The effect of this would be the standardization in a large measure of hull construction and hull inspection, with the result that we would know after a vessel had been built whether it was actually safe for the purpose for which it was constructed. It is no reflection upon the local inspectors, who at present have original jurisdiction, to state that they are not qualified to pass upon hull construction, and therefore the necessity is emphasized for the creation of a board of naval architects. It may be advanced in opposition that it would require an additional expenditure of money to carry on this work, but it may be stated in answer that the additional expenditure of money would be more than justified by the safer conditions which would unquestionably be obtained.

It might also be stated that one of the results that could probably be developed from such procedure would be the classification of ships by the Federal Government, instead of having this done, as at present, by Lloyds or by certain classification societies. If the classification societies should oppose this proposition, the answer of this Bureau is that it is a proper function of the Federal Government to classify these vessels. And could there be a better time than now for the United States Government to undertake this work under the direction of this Service, when the American merchant marine is being so rapidly rehabilitated and when the American flag is again being placed upon the ocean?

Reference has been made above to the desire that was in the minds of all of us at the time of the *Eastland* disaster of in future providing against the instability of ships. As the result of the regulations adopted by the Board of Supervising Inspectors after the *Eastland* disaster, it is now provided that when inspectors have any reason to question the stability of any vessel under their jurisdiction they shall require the owners of the vessel to make inclining tests of such vessel, under the supervision of expert naval architects provided by the Department of Commerce. That is good so far as it goes, but it does not discover the condition until after the vessel has been navigated, and until after the risk has been taken by those who travel upon the ship. It is the wish of the Bureau, therefore, to have enacted by the Board of Supervising Inspectors, without delay, a rule that will require a stability test of all vessels that are built, these tests to be conducted under the direction of naval architects provided by the Department of Commerce. This, it will be observed, is a narrower proposition than that of the creation of a board of naval architects to work in the Office of the Supervising Inspector General, whose function it would be officially to pass upon hull construction, and it is only suggested as something that will meet, and possibly control, a dangerous situation until Congress shall have acted in such manner as to provide for the board of naval architects referred to above.

As a matter of evolution, it is quite as necessary, it will be found, if a moment's thought be given to the matter, that there should be uniform approval of boiler construction in the Office of the Supervising Inspector General, and it may be stated that, so far as the present procedure is concerned, the Board of Supervising Inspectors now passes upon water-tube and coil boilers, whereas Scotch boilers and boilers of a similar design are passed upon by the boards of local inspectors. It is desirable, in the opinion of the Bureau, that the design of all boilers used for marine purposes should be passed upon by one central authority. This could be done by having, in the Office of the Supervising Inspector General, a corps of experts whose business it would be to pass upon work of this kind. It would be desirable to have it done in this manner, because, as at present, where the local inspectors have original jurisdiction with reference to certain classes of boilers, it is only reasonable to state that it is impossible now to obtain that uniform administration of the law with which the Supervising Inspector General is charged. The result of employing experts for this purpose in the Office of the Supervising Inspector General would be absolute uniformity in the approval of boilers, and, when examined and approved in that Office, copies of blue prints and specifications could be sent to the local inspectors where the boilers were to be built and where the vessels in which the boilers were to be installed would be inspected. The function, therefore, of that system would be that the local inspectors would not have boilers to approve, but would simply have to see that the boilers were built in accordance with the blue prints and specifications approved in the central office. This, it must be conceded, would require an additional expenditure of money, but it would be an expenditure that would be more than justified, because you would have uniform boiler construction, and without any delay whatever.

During the war, when there was such a large number of boilers being constructed for the Emergency Fleet Corporation, the business of passing upon the water-tube and coil boilers was easily taken care of by the Board of Supervising Inspectors, or by an executive committee of that board, which could be called for that purpose, but, with reference to Scotch boilers, it was found necessary, in order to expedite the work, to instruct the local inspectors at Philadelphia, Pa., to pass upon such construction and to take up the matter with the Emergency Fleet Corporation, whose headquarters was then at Philadelphia. That may not have been absolutely consistent with the rule, but it was absolutely necessary in order to obtain businesslike results under congested conditions. The better way would have been to have had the authority centralized, so that the proper type of boiler could have been approved by the Board of Supervising Inspectors, or by experts working in the central office under the direction of the Supervising Inspector General.

### EXAMINATION OF APPLICANTS FOR LICENSES.

There have been criticisms appearing from time to time with reference to the examination of applicants for licenses, it having been advanced that the methods of the local inspectors are careless; that old questions are repeated; and that a better class of licensed officers could be obtained if better methods were used in the examination of these men, and it has been suggested that it would be better to follow the procedure of the Civil Service Commission in having questions prepared at one central office—say in the office at Washington—and having these questions sent out to the local inspectors. There are arguments which could be advanced on both sides of the question, but it is to be remembered that the United States is a large country, representing many varied local conditions, and that the matter of examining applicants is one upon which the respective boards of local inspectors are better informed than any central authority could ever be. If we should follow the methods of the Civil Service Commission, there would be no end of delay in obtaining licensed officers, and there would exist a tremendous congestion in the matter of obtaining such officers for the ships. These men come to the boards of local inspectors not once or twice a month, but usually every day, and the local inspectors adjust their business so as to examine these applicants as they appear. As a result, the Service has been able under war conditions to obtain licensed officers for the rapidly increasing number of ships. That is a greater thing to have accomplished than even the building of the ships, because, in such a country as this, with its unbounded resources and manufacturing facilities, there was no difficulty in obtaining steel for ship construction, but it was a greater question to obtain men who were able to navigate these ships when they were launched. There has necessarily been some delay in obtaining licensed officers, but, when all factors have been considered, one must admit that there has been no delay on the part of this Service and that wonderful results have been obtained in the matter of securing licensed men. Even were it to be admitted for argument's sake that some men have been obtained who were not as efficient as could have been obtained in time of peace, yet one must have in mind that this country has been at war and the thing that counts at such times is the results that have been obtained.

### BOILER PRESSURE.

The criticism has been frequently advanced that the rules of the Board of Supervising Inspectors are not up to date with reference to boiler pressures; that proper credit is not given for the riveting plan above double riveting; and objection has been made to the practice of the Service with reference to hydrostatic pressure. The Bureau, having had in mind the fact that the Steamboat-Inspection Service has been open to some criticism in reference to its rules in regard to boiler pressure, has had drafted a bill looking to the amendment of sections 4433 and 4418, Revised Statutes, and that bill is set forth to-day in Senate bill 574. It may not be out of place in this report to speak of the reasons why it is necessary that legislation should be enacted which will give the Board of Supervising Inspectors the authority requisite to make rules with reference to boiler pressures. Section 4433, Revised Statutes, as it at present exists, reads as follows:

> The working steam-pressure allowable on boilers constructed of plates inspected as required by this Title, when single-riveted, shall not produce a strain to exceed one-sixth of the tensile strength of the iron or steel plates of which such boilers are constructed; but where the longitudinal laps of the cylindrical parts of such boilers are double-riveted, and the rivet-holes for such boilers have been fairly drilled instead of punched, an addition of twenty per centum to the working-pressure provided for single-riveting may be allowed; *Provided*, That all other parts of such boilers shall correspond in strength to the additional allowances so made; and no split-calking shall in any case be permitted.

The Bureau recommends that the section be amended so as to read as follows:

> The working steam pressure allowable on all boilers inspected as required by Title LII shall be determined by the rules of the Board of Supervising Inspectors with the approval of the Secretary of Commerce.

The purposes of the proposed amendments in this section are, first, to do away with the obsolete rule contained in the present law, which prescribes a working steam pressure for single-riveted joints, without taking into consideration the percentage of strength of the riveted joint, and allows 20 per cent additional pressure for double-riveted joints, but which does not allow a greater working pressure for triple-riveted and quadruple-riveted, etc., lap and butt joints, for which greater working pressure should be allowed on account of the greater strength of the triple-riveted and other joints of greater strength than the double-riveted joints.

This greater allowable working pressure for the stronger forms of riveted joints has for years been desired by boiler users.

The present law does not give an incentive for the building of boilers with stronger joints that will carry a greater working pressure with but slight increase in the amount of material required for boiler shell than for double-riveted joints.

Further, by placing the authority to prescribe rules for working pressure on boilers with the Board of Supervising Inspectors, with the approval of the Secretary of Commerce, the board could prescribe rules that would meet the various conditions of boiler construction, taking into consideration the percentage of strength of the various kinds of riveted joints, as is now almost the universal practice.

That part of the proviso of the section which reads "No split-calking shall in any case be permitted" has been omitted, as the rules for calking would be prescribed by the Board of Supervising Inspectors in connection with rules for riveted joints.

Section 4418, Revised Statutes, with reference to hydrostatic test of boilers, as amended by the act of Congress approved March 3, 1905, reads as follows:

> The local inspectors shall also inspect the boilers and their appurtenances in all steam vessels before the same shall be used, and once at least in every year thereafter, and shall subject all boilers to the hydrostatic pressure. All such vessels shall comply with the following requirements, namely: That the boilers are well made, of good and suitable material; that the openings for the passage of water and steam, respectively, and all pipes and tubes exposed to heat, are of proper dimensions and free from obstructions; that the spaces between and around the flues are sufficient; that flues, boilers, furnaces, safety valves, fusible plugs, low-water indicators, feed-water apparatus, gauge cocks, steam gauges, water and steam pipes connecting boilers, means of prevention of sparks and flames from fire doors, low-water gauges, means of removing mud and sediment from boilers, and all other such machinery and appurtenances thereof, are of such construction, shape, condition, arrangement, and material that the same may be safely employed in the service proposed without peril to life; and the local inspectors shall satisfy themselves by thorough examination that said requirements of law and regulations in regard thereto have been fully complied with. All boilers used on steam vessels and constructed of iron or steel plates, inspected under the provisions of section forty-four hundred and thirty, shall be subjected to a hydrostatic test, in the ratio of one hundred and fifty pounds to the square inch to one hundred pounds to the square inch of the working steam power allowed. No boiler or flue pipe, nor any of the connections therewith, shall be approved, which is made, in whole or in part, of bad material, or is unsafe in its form, or dangerous from defective workmanship, age, use, or other cause.

It is recommended that the section be amended so as to read as follows:

> The local inspectors shall also inspect the boilers and their appurtenances in all steam vessels before the same shall be used, and once at least in every year thereafter, and shall subject all boilers to the hydrostatic pressure. All such vessels shall comply with the following requirements, namely: That the boilers are well made, of good and suitable material; that the opening for the passage of water and steam, respectively, and all pipes and tubes exposed to heat, are of proper dimensions and free from obstructions; that the spaces between and around the flues are sufficient; that flues, boilers, furnaces, safety valves, fusible plugs, low-water indicators, feed-water apparatus, gauge cocks, steam gauges, water and steam pipes connecting boilers, means of prevention of sparks and flames from fire doors, low-water gauges, means of removing mud and sediment from boilers, and all other such machinery and appurtenances thereof, are of such construction, shape, condition, arrangement, and material that the same may be safely employed in the service proposed without peril to life; and the local inspectors shall satisfy themselves by thorough examination that said requirements of law and regulations in regard thereto have been fully complied with. All boilers used on steam vessels and inspected as required by Title LII shall be subjected to such hydrostatic test as shall be determined by the rules of the Board of Supervising Inspectors with the approval of the Secretary of Commerce. No boiler, flue, or pipe, nor any of the connections therewith, shall be approved, which is made, in whole or in part, of bad material, or is unsafe in its form, or dangerous from defective workmanship, age, use, or other cause.

It is the desire of the Bureau that the amendments be enacted into law so as to leave with the Board of Supervising Inspectors the authority for determining the hydrostatic test in connection with the rules for riveting which would be adopted by the board, all of such procedure, of course, to be approved by the Secretary of Commerce.

The proposition of giving the Board of Supervising Inspectors the authority to make modern its rules with reference to boiler pressures is consistent and is in line with the whole theory of reconstruction absolutely necessary to be adopted in order that the rehabilitation of the American merchant marine may go forward now without any delay. It will enable the Steamboat-Inspection Service to place itself absolutely abreast of the best modern practice and to lend a helping hand, so far as boiler construction is concerned, in connection with the great problem of ship construction.

## TRAVELING INSPECTORS.

There are now four traveling inspectors in the Service. One was busily engaged during the last fiscal year with the examination of applicants on the Great Lakes who were desirous of obtaining licenses for ocean service. The examinations were conducted in the offices of the local inspectors on the Great Lakes, and it was the duty of the traveling inspector to pass upon these examinations; the licenses being issued, of course, by the respective boards of local inspectors where the examinations took place. On the Pacific coast, the traveling inspector, whose headquarters is at San Francisco, Calif., was engaged for a considerable part of the time in doing work as an assistant inspector, because of the tremendous pressure that was brought to bear upon the Service incident to the shipbuilding program. The traveling inspector, whose headquarters is in the central office, has been busily engaged in going out on special duty making stability tests, as he has been directed by the central office, and also in checking up the boatage of inspected vessels. All of the traveling inspectors are now engaged in the actual work of making reinspections of vessels, and, judging by the reports received, while it would seem that the local inspectors have been careful and have exercised every precaution in the certification of vessels, the traveling inspectors are doing a work that can not be overestimated in connection with the follow ups, and these follow ups have reference not only to the work of the local inspectors, but also to the licensed officers who are on the ships. Conditions exist that require attention, and they are at once corrected when discovered.

This fall it is the plan of the central office to have the traveling inspectors stationed at the *Soo* for a while. Their business will be to observe the loading of vessels as they pass through, and when their work there shall have been concluded it is the intention of the Bureau to have a conference in the central office with all of them.

It is to be borne in mind that one of the functions of the Supervising Inspector General is to obtain uniform administration of the law. That is absolutely necessary, and it is eminently right. It is more than necessary at this time with the expansion of the American merchant marine to see that absolutely uniform results shall be obtained, and there is no arm of the Service that the Supervising Inspector General may use with more effectiveness than these four traveling inspectors, whose work it is to travel among the different districts, to board ships in all parts of the country, and to call at the offices of the local inspectors with a view to following up further the complaints made to the central office and which have been previously followed up by the local inspectors and by the supervising inspectors. I can not speak too highly of the efficiency which must come to the Service by the proper use of this valuable corps of traveling inspectors, and you may be assured that they are being used in the most effective manner, to the end that the high standard already reached by the Steamboat-Inspection Service may not only be maintained, but that that standard may be raised still higher.

## CIVIL SERVICE FOR THE SUPERVISING INSPECTORS.

The supervising inspectors of the Service are not under the classified civil service. They are all presidential appointees; but they should all be under the classified civil service. The reason why this should be done is that this important branch of the Steamboat-Inspection Service ought to be absolutely immune from politics. It has been my unswerving purpose, and my record will show that this is the fact, to keep the supervising inspectors absolutely out of politics, and quite generally the supervising inspectors are men who have been promoted from the position of local inspector. When they are appointed to that position, they come out of the classified civil service, and they should, when they become supervising inspectors, be given the same protection under the classified civil service which they had before their promotion. You have given me splendid support in the maintenance of the Board of Supervising Inspectors free from politics. It is, nevertheless, a fact that at every presidential election there is a feeling of uneasiness and uncertainty as to what the future may bring to the supervising inspectors. That condition ought not to exist. It can be removed, and it can be remedied, by having these men placed under the classified civil service, and I urgently recommend that this be done.

### MORE PAY FOR THE FIELD CLERKS.

It will be recalled that by the act of Congress approved July 2, 1918, the pay of the inspectors of the Steamboat-Inspection Service has been materially increased. While it is true that the increase of pay was not as great as it should have been and proportionate with the increase received by men in outside employment doing the same kind of work, it was, nevertheless, a substantial increase. That should have been given years before, and by giving it at the time it was, it has been the only means by which it was possible to hold the trained inspectors, as the inducements outside the Service were so attractive that it was rapidly losing its best men.

It is true that the clerks in the Steamboat-Inspection Service do receive the same bonus as other clerical employees, but, aside from the fact that that bonus is not sufficient to meet the increased cost of living, this Office submits that the work of the field clerks in the Steamboat-Inspection Service is peculiar to itself. It is no argument to say that it is clerical work, work of the same character as that done by clerks in other branches of the Government. It is clerical work with this difference, however, that it is a peculiar kind of clerical work. Any lawyer knows that the maritime law is entirely different from the common law, and that the rules and procedure in admiralty are entirely different from those in other procedure, and just in the same way as the proposition of discipline upon a ship and familiarity with a ship is peculiar, so the organization of the Steamboat-Inspection Service is peculiar in itself. There is no other bureau in the Government that is as unique in its organization and that has as many exceptional and unusual conditions to meet as the Steamboat-Inspection Service. The clerks in that Service in the same way are peculiarly trained for the work they have to do. It is true that we get this clerical force from the same register of the Civil Service Commission from which other bureaus receive their clerical force, but it is also true that after these persons are obtained they must be especially trained before they become in every way efficient for the work they have to do. It is to be borne in mind that if there is any respect in which there has been tremendous expansion in this country, it has been in shipping, and, if there has been any service upon which the pressure of increased work has been brought to bear, it is the Steamboat-Inspection Service. This work has been done without a murmur, and, if the inspectors have been rewarded, so should the clerks. Think of it! The senior clerk in the office of the local inspectors at New York, N. Y., receives only $1,500 per annum, and, with the bonus that is allowed, his salary is $1,740 per annum. Yet here is a man who has had years of experience in the Steamboat-Inspection Service and is familiar with all of the procedure of that Service, and what is said of him might be said of many others throughout the entire Service. Think of it, also, that persons, whether men or women, are appointed at $900 per annum! Can we be expected to get the best clerks at that money? Can we be expected to maintain the efficiency of the Service with such salaries? It is a mistake to say that all the important work done in this Service is done by the inspectors. If ships are inspected, they must be certificated; and if men are examined for licenses, their licenses must be prepared; and if the clerical force is inefficient, then there must result congestion; and then, if congestion results, it reflects itself upon the shipping.

While the inspectors have been rewarded by an increase of pay, the clerks have not. Is it any wonder, then, that they have become discouraged? Is it any wonder that many of them are in despair? I can not too strongly urge the passing of legislation that will give to the clerks of this Service salaries commensurate and in keeping, not alone with the cost of living at this time, but also with their efficiency.

### VISION.

It was said with authority long ago that "Without a vision, the people perish." If we apply that great truth, uttered so many years ago, to modern conditions, and especially to our own country, we must acknowledge and realize that if there ever was a time when we must have vision it is now. For we must face the great problems that confront us, and we must be able to prove that our civilization can and will stand the test. Now it is that we must be able to see beyond the room in which we work, to see beyond the people whom we meet upon the street, and to see beyond the year or century in which we live. We must be able to see centuries ahead, if you please. We must know that, if we make a false step, we may not as a people be able to retrace it. We must now find what the policy shall be, not alone for the building of ships, but for the retaining of them under the American flag. We must establish again, once and for all and never swerve from that attitude, the United States as a maritime power. It was a merciful Providence rather than a heroic people that saved us in this last war, because it happened that we had as allies those who had ships. It has been demonstrated beyond a doubt that he who controls the sea controls the world. There may be great armies and there may be great armaments, but without great merchant fleets there can not be supremacy. Why do we wish this supremacy? We do not desire it in the same spirit in which Germany wished it—in order that we may have power for its own sake—but we wish it that we may protect our ideals; and I refer thus briefly to the necessity of this vision, so that everyone in the Steamboat-Inspection Service may realize that he has his own part to play, no matter how humble it may be, in this great campaign for the rehabilitation of the American merchant marine. At times we may become discouraged with our compensation, and at times we may ask ourselves "What is the use?" but if we stop to reflect upon the great work we are doing, and upon the patriotism which must be at the bottom of all of that work, I am sure every officer and employee of the Service will respond willingly to long hours and to arduous duties, and I know that if we do this we shall not lose the esprit de corps that has distinguished this splendid Service during the war with Germany.

### APPENDIX.

There is attached hereto an appendix containing general statistics of the Service compiled from the reports of the supervising inspectors of the various districts for the year ended June 30, 1919, indicating the nature and extent of the work of the Service.[a]

Respectfully,

Geo. Uhler,
*Supervising Inspector General.*

To Hon. William C. Redfield,
*Secretary of Commerce.*

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[a] Appendix is published in the pamphlet edition of the report of the Supervising Inspector General, but omitted from this volume.

# REPORT

OF THE

# COMMISSIONER OF NAVIGATION

# REPORT

OF THE

# COMMISSIONER OF NAVIGATION.[a]

DEPARTMENT OF COMMERCE,
BUREAU OF NAVIGATION,
*Washington, September 15, 1919.*

SIR: I have the honor to submit herewith my annual report for the fiscal year ended June 30, 1919.

## GENERAL CONDITIONS.

The first four and one-third months of the fiscal year up to the armistice of November 11, 1918, with the three immediately preceding months, was the period of our greatest effort to win the war. All our ships structurally available for military purposes were so employed; they were officered and manned by the commissioned officers and enlisted men of the Navy rather than by merchant crews; our shipyards were turning out tonnage as rapidly as possible to win the war, with the purposes of trade only remotely in view or not at all; and civil authority and commercial considerations were in all phases of maritime affairs subordinated to military exigencies. The momentum thus acquired in these directions could not be checked at once by the armistice, and, of course, should not have been; but the machinery was swung around to bring back to the United States as rapidly as possible the millions comprising our forces in Europe. Though this task was accomplished with remarkable expedition and success, it consumed, nevertheless, practically the rest of the fiscal year, and the movement of supplies for those at whose side we fought took the place, to an extent, of the movement of supplies for our armies abroad. During the fiscal year covered by this report the largest and most important part of our merchant marine was not an instrument of commerce, but a weapon of war. The extent of our maritime effort since 1917, culminating, but not ceasing, with this year's victory, may be measured by the fact that the sums Congress authorized the Shipping Board to expend have been greater than the book value of all the merchant tonnage of the world before the outbreak of the war in 1914. These general observations are made at the outset for the reason that they qualify nearly all the statements in the following pages and serve to make clearer much that would otherwise call for repeated qualification and explanation.

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[a] Appendixes and statistical tables referred to in the text following are printed in the pamphlet edition of the Commissioner's report, but omitted from this volume.

## AMERICAN SHIPPING GROWTH SINCE 1914.

It is opportune to show, first, what changes have taken place year by year since 1914 in our merchant shipping under register for the foreign trade and under enrollment and license for the coasting trade and fisheries, giving the gross tonnage (100 cubic feet of closed-in space equaling a gross ton) on June 30 for each year:

| June 30— | Foreign trade. | Coasting trade. | | Total. |
|---|---|---|---|---|
| | | Great Lakes. | Sea and river. | |
| 1914 | 1,076,152 | 2,882,922 | 3,969,614 | 7,928,688 |
| 1915 | 1,871,543 | 2,818,000 | 3,699,886 | 8,389,429 |
| 1916 | 2,191,715 | 2,760,815 | 3,517,119 | 8,469,649 |
| 1917 | 2,446,399 | 2,769,824 | 3,654,814 | 8,871,037 |
| 1918 | 3,603,706 | 2,708,523 | 3,612,289 | 9,924,518 |
| 1919 | 6,669,726 | 2,635,680 | 3,601,894 | 12,907,300 |

American shipping registered for foreign trade is over 600 per cent of the corresponding tonnage in 1914, while in each branch of the coasting trade the decline has been nearly 10 per cent, because the shipping of the Great Lakes and of the coasting trade along the seaboard was drawn upon heavily to meet war needs. With the return of normal times such ships will be restored to the trades for which they were designed; furthermore, much of the shipping built in the United States with public funds is adapted to the shorter voyages of the home trade and will find there its opportunities. The decline of tonnage in all branches of the coasting trade will be more than made good during the coming year, and should thus reduce the pressure on our railway systems and become a factor in restoring more normal conditions of life.

Many of the most useful ocean steamers employed from our entry into the war in transporting troops, supplies, and munitions across the Atlantic were withdrawn from our coasting trade and may continue in the foreign trade, which offers at present greater profit than the domestic trade.

Under authority already vested in the Secretary of Commerce and under other authority later bestowed also upon the Shipping Board, foreign ships have engaged to a slight extent in the coasting trade, and, to help meet the demands for food, foreign vessels were permitted to engage also in the fisheries.

The tonnage of shipping registered for the foreign trade just stated can not all remain in that column, because many of the ships comprised in it are too small to engage profitably in that trade, and for that reason, and others, part of it has not, in fact, been so employed. Any subtraction on this account, however, even now can be made good by the return to trade of a considerable number of large steamships, particularly the largest of the seized German ships, which have been employed as Army transports, operated by the Navy and not under the register granted to ships in trade. On June 30, 1919, these ships numbered 45 of 400,000 gross tons. The Army transport service will have to be maintained at least during the current year, and only part of this tonnage, to be determined by Congress, will become available for commercial purposes.

## AMERICAN SEAGOING SHIPS.

In these five years our merchant shipping has increased 5,000,000 gross tons, and the increase has been wholly in seagoing vessels of 1,000 gross tons or over. The table below shows the number and gross tons of seagoing vessels of 1,000 gross tons or over of the several types on June 30 at the end of each fiscal year (except 1915) and also on September 30, 1919, showing the current rate of progress. Sailing tonnage has been virtually stationary, the increase in seagoing wooden steamers from[a] 8 of 10,595 gross tons on June 30, 1914, to 293 of 693,541 gross tons on June 30, this year, is to be regarded more as a sacrifice in the effort to put forth all our resources than as a permanent addition to our commercial fleet. The substantial addition has been in steel steamers, of which the tonnage is fourfold greater than in 1914.

| June 30— | Sailing and schooner barges, wood and steel. | | Steam and gas vessels. | | | | Total. | |
|---|---|---|---|---|---|---|---|---|
| | | | Wood. | | Steel. | | | |
| | *No.* | *Gross tons.* | *No.* | *Gross tons.* | *No.* | *Gross tons.* | *No.* | *Gross tons.* |
| 1914 | 318 | 528,403 | 8 | 10,595 | 429 | 1,589,733 | 755 | 2,128,731 |
| 1916 | 315 | 523,204 | 13 | 17,799 | 601 | 2,354,557 | 929 | 2,895,560 |
| 1917 | 327 | 538,196 | 41 | 58,895 | 660 | 2,696,368 | 1,028 | 3,293,459 |
| 1918 | 315 | 518,216 | 91 | 161,425 | 874 | 3,627,251 | 1,280 | 4,306,892 |
| 1919 | 329 | 533,580 | 293 | 693,541 | 1,436 | 6,072,901 | 2,058 | 7,300,022 |
| 1919, Sept. 30 | 350 | 558,835 | 360 | 876,811 | 1,628 | 7,051,449 | 2,334 | 8,487,095 |

## ORIGINS OF THE FLEET.

The seagoing fleet of ships of 1,000 gross tons or over as it existed on June 30, 1919, was of several distinct origins. It included ships under the flag before the war and still remaining on the register on the date named, aggregating 1,698,750 gross tons; foreign built ships admitted to registry under the ship-registry act of 1914 and remaining on the register, 658,115 gross tons; also 11,580 gross tons of foreign-built wrecks admitted to register. The seized former German ships, so far as registered, aggregated only 248,406 gross tons, the larger portion, not included, being in the Army transport service. The remainder of the fleet were ships built in the United States during the fiscal years beginning July 1, 1914. The ships built include those built for private owners before June, 1917, when Congress made the first of its great appropriations for the Shipping Board, and those building for or ordered by American and foreign owners requisitioned and retained by the Shipping Board which appear in the statement of those built since June 30, 1917. Included in these are 66 of 301,112 gross tons for American owners, 135 of 520,663 gross tons for British owners, 26 of 120,633 gross tons for French owners, 28 of 121,836 gross tons for Norwegians, 3 of 15,371 gross tons for Italians, 4 of 10,686 gross tons for Danes, and 2 of 10,270 gross tons for Russians.

Out of the 7,300,022 gross tons, accordingly, only 2,616,851 gross tons, slightly more than one-third, were built before 1914. Of the remainder, as indicated, 1,110,571 gross tons were building or under contract in 1917 for American or foreign owners according to their plans, though completed under war conditions in the United States, so that, broadly speaking, half the larger seagoing tonnage under the flag on June 30, 1919, had a more or less substantial commercial basis. The balance of the fleet, all new ships built from Government design under Government direction and wholly with public funds, represents our effort to win the war so far as recorded on the registry books of the customhouse. Following are details:

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[a] These figures were increased to 19 vessels of 26,121 gross tons on June 30, 1919, due chiefly to transfers from the Great Lakes and the rebuilding and enlarging of vessels previously measuring less than 1,000 tons.

| Sources of tonnage now in lists. | Sailing vessels and schooner barges, wood and steel. | | Steam and gas vessels. | | | | Total. | |
|---|---|---|---|---|---|---|---|---|
| | | | Wood. | | Steel. | | | |
| | No. | *Gross tons.* | No. | *Gross tons.* | No. | *Gross tons.* | No. | *Gross tons.* |
| In fleet of June 30, 1914 | 210 | 347,959 | 19 | 26,121 | 372 | 1,324,670 | 601 | 1,698,750 |
| Admitted from foreign flags: | | | | | | | | |
| British | 11 | 20,857 | | | 58 | 246,103 | 69 | 266,960 |
| German | | | | | 25 | 130,350 | 25 | 130,350 |
| Japanese | | | | | 16 | 89,772 | 16 | 89,772 |
| Austrian | | | | | 14 | 56,930 | 14 | 56,930 |
| Dutch | | | | | 6 | 26,577 | 6 | 26,577 |
| Cuban | | | | | 7 | 21,173 | 7 | 21,173 |
| Danish | | | | | 3 | 10,805 | 3 | 10,805 |
| Chilean | 3 | 5,832 | | | 1 | 4,725 | 4 | 10,557 |
| Norwegian | | | | | 2 | 8,188 | 2 | 8,188 |
| French | | | | | 2 | 6,595 | 2 | 6,595 |
| All other flags | 3 | 4,484 | | | 9 | 25,724 | 12 | 30,208 |
| Repaired foreign wrecks, act Feb. 24, 1915 | 6 | 8,728 | | | 1 | 2,852 | 7 | 11,580 |
| Seized German vessels | 7 | 15,795 | | | 44 | 232,611 | 51 | 248,406 |
| Built year ended June 30— | | | | | | | | |
| 1915 | | | | | 12 | 62,222 | 12 | 62,222 |
| 1916 | 6 | 9,495 | 2 | 3,063 | 34 | 170,942 | 42 | 183,500 |
| 1917 | 15 | 22,288 | 18 | 26,047 | 61 | 317,436 | 94 | 365,771 |
| 1918 | 33 | 46,510 | 47 | 91,623 | 190 | 852,916 | 270 | 991,049 |
| 1919 | 35 | 51,632 | 207 | 546,687 | 579 | 2,482,310 | 821 | 3,080,629 |
| Total | 329 | 533,580 | 293 | 693,541 | 1,436 | 6,072,901 | 2,058 | 7,300,022 |

## SIZE OF OCEAN STEAMERS.

The ocean steamers included in the table above number 1,729 of 6,766,442 gross tons, of which 1,436 of 6,072,901 gross tons are steel and 293 of 693,541 gross tons are wood. The steel steamers are of the following gross tonnages:

| Gross tons. | No. | Total tons. | Gross tons. | No. | Total tons. |
|---|---|---|---|---|---|
| 1,000-2,000 | 112 | 186,069 | 8,000- 9,000 | 26 | 217,468 |
| 2,000-3,000 | 474 | 1,153,093 | 9,000-10,000 | 3 | 28,392 |
| 3,000-4,000 | 180 | 627,336 | 10,000-11,000 | 18 | 186,707 |
| 4,000-5,000 | 133 | 609,897 | 11,000-12,000 | 1 | 11,440 |
| 5,000-6,000 | 215 | 1,192,207 | 12,000-13,000 | 2 | 24,463 |
| 6,000-7,000 | 208 | 1,324,640 | 13,000-14,000 | 3 | 40,608 |
| 7,000-8,000 | 60 | 449,979 | 20,000 and over | 1 | 20,602 |

The wooden ocean steamers are of the following tonnages:

| Gross tons. | No. | Total tons. |
|---|---|---|
| 1,000-2,000 | 74 | 110,457 |
| 2,000-3,000 | 178 | 455,978 |
| 3,000-4,000 | 41 | 127,106 |

## WORLD'S SHIPPING, 1914–1919.

The preceding tables are meant to show more important changes in American merchant shipping, especially in ocean steamers, by which over 90 per cent of the world's foreign commerce by sea is carried, wrought between June, 1914, and June, 1919, by nearly five years of war. The changes which have taken place in the fleets of the rest of the world affect materially the consideration of most questions relating to our own ships. The best available returns of the world's shipping for the periods named are those of Lloyds' Register, which include ships of 100 gross tons or over, including those launched, but not yet registered. The following is the summary in round numbers of Lloyds' returns of steam vessels of the several nations on June 30, 1914 and 1919, with losses or gains, respectively:

| Country. | June, 1914. | June, 1919. | Increase (+) or decrease (−). |
|---|---|---|---|
| | *Gross tons.* | *Gross tons.* | *Gross tons.* |
| United Kingdom | 18,892,000 | 16,345,000 | −2,547,000 |
| British Dominions | 1,632,000 | 1,863,000 | + 231,000 |
| United States: | | | |
| Seagoing | 2,027,000 | 9,773,000 | +7,746,000 |
| Great Lakes | 2,260,000 | 2,160,000 | − 100,000 |
| Austria-Hungary | 1,052,000 | 713,000 | − 339,000 |
| Denmark | 770,000 | 631,000 | − 139,000 |
| France | 1,922,000 | 1,962,000 | + 40,000 |
| Germany | 5,135,000 | 3,247,000 | −1,888,000 |
| Greece | 821,000 | 291,000 | − 530,000 |
| Holland | 1,472,000 | 1,574,000 | + 102,000 |
| Italy | 1,430,000 | 1,238,000 | − 192,000 |
| Japan | 1,708,000 | 2,325,000 | + 617,000 |
| Norway | 1,957,000 | 1,597,000 | − 360,000 |
| Spain | 884,000 | 709,000 | − 175,000 |
| Sweden | 1,015,000 | 917,000 | − 98,000 |
| Other countries | 2,427,000 | 2,552,000 | + 125,000 |
| Total steam tonnage | 45,404,000 | 47,897,000 | +2,493,000 |
| Sail tonnage (net) | 3,686,000 | 3,022,000 | − 664,000 |
| Grand total | 49,090,000 | 50,919,000 | +1,829,000 |

It will be noted that the total tonnage of seagoing American steamers is much larger than the totals given in the earlier statements in this report or statements in detail in later pages. This difference is due to the fact that merchant vessels of the United States are not included in the returns of the Bureau of Navigation until they have received at the customhouses registers or enrollments entitling them to engage in trade. They come within Federal jurisdiction, and they remain under that jurisdiction by virtue of those documents. The great tonnage employed as Army transports, as has been stated, is not included in the returns of this Bureau, but finds an appropriate place in Lloyds' figures. Lloyds' returns include many ships launched, but not ready for registry, or not registered, while the returns of the Bureau of Navigation include only ships lawfully qualified for trade.

The ratification and execution of the treaty of peace by which Germany in reparation for submarine warfare surrenders all her former ships over 1,600 gross tons and from one-half to one-fourth of smaller ships will reduce to about 700,000 gross tons the 3,247,000 tons assigned to Germany in the table and will increase correspondingly the tonnage of the allied nations, and the same is true of the 713,000 tons assigned to Austria-Hungary.

The net losses of Europe in steamers are 4,000,000 gross tons, excluding German and Austrian losses, which are mainly due to capture and transfer to the American and allied flags under which they have contributed to gains. In America we gave most thought, naturally, to submarine assaults on the great ocean liners, many of which we knew, but the bulk of the European war losses were of the smaller ships, with which the trade by sea between European countries is conducted. These ships were almost constantly subject to attack. A glance at the map will show the great geographical difference between the sea trade between European countries and that of the Americas. Europe in all directions is deeply penetrated by arms of the sea—the Baltic and North Seas, and the Mediterranean, Adriatic, Aegean, and Black Seas. These give to the salt-water foreign trade of densely populated countries of Europe an importance not always appreciated, and they determine, too, the types of ships required, for the voyages are relatively short and frequent, and smaller ships are at an advantage in such trades. The longer voyages of the foreign trade and even of the coasting trade of America require larger ships. It is a mistake, therefore, to condemn as wholly wasteful the construction of smaller ships—say, under 3,000 gross tons—in this country during the war. While they are not as well adapted to our own trade as larger ships, they are of the tonnage with which the trades of the several seas which penetrate Europe are usually conducted and in the proper places may be serviceable, especially in the near future. The merchant marine of a country is not to be judged by its total gross tonnage alone, but by its adaptability to the country's needs, and one of the sources of Britain's commercial importance has been the willingness of her shipowners to dispose of ships which on account of size, age, or other factors had ceased to become the most efficient instruments of commerce and to build newer, larger, and better ships. Broadly speaking, the geographical reasons which suggest smaller ships for much of the trade of the Eastern Hemisphere and larger ships for the Western, point to tramp management for the former and liner management for the latter. Just as agriculture in Europe takes the form of intensive cultivation of small areas and with us the form of cultivation of large areas by machinery, so in shipping we are likely to do better through the organization of large corporations and large fleets rather than by undertaking the tramp line of business with many smaller companies.

The absolute and relative increase of American tonnage, it is repeated, is the gratifying evidence of our determination to help win the war, in its way as noteworthy as was the raising and transportation of our armies to Europe, but in neither case were commercial considerations involved and in neither case were commercial results obtained. A considerable part of the tonnage now under the flag is not a source of maritime strength to us, but, if treated as our general business good sense would treat an analogous matter ashore, such tonnage may be so disposed as to add to the world's comfort and wealth, in which we shall share.

## GROWTH OF AMERICAN SHIPBUILDING.

Up to the outbreak of the war the largest annual output of American shipyards was 1,457 vessels of 614,216 gross tons during the fiscal year ended June 30, 1908, of which 216 of 341,165 gross tons were built on the Great Lakes. The largest recent annual output of the seaboard yards had been 291,516 gross tons in 1901. Two-thirds of the seagoing tonnage now under the American flag have been built since 1914, while of the tonnage now under foreign flags more than two-thirds was built before 1914. At first blush these facts would seem to give our present fleets a greater advantage than even the tonnage figures alone indicate, but we shall fare better in the future if we face at once facts as they stand. Of necessity, during the war the main object sought was the construction of the largest amount of tonnage in the shortest possible time. To accomplish this result all ordinary commercial considerations had to yield place. Usually ships are built in the United States with a view to their employment in particular trades, and, while this adds to cost and time of construction, it has made our ships hitherto especially long-lived. Our war construction was confined to cargo boats of a few types, and of each the maximum output was sought. In taking an account of stock now we find, as was anticipated, that we have more of some types than our commerce requires and less of others. Our greatest advantage lies in the fact that many of our new ships use oil as fuel.

Again, it is at least a question whether the fabricated ship, so called, the ship of which the elements are manufactured in the steel plants and then assembled in the shipyard, are not, from their simpler construction handicapped through life by inability to carry the full cargoes of ships constructed in the usual manner. The great speed with which some of our ships were built, or put together, helped to win the war; but it tells, of course, against careful and durable construction and has, in fact, already given to repairs a larger place in marine economy and finance than has been usual with American ships. The number of shipyard employees could not have been increased about tenfold in five years, and the output increased virtually twentyfold without lowering somewhat American standards of construction. These matters were the necessary incidents of war, and they are considered only for their bearing on a fair appreciation of our maritime resources. On the other hand, it should be borne in mind that two-thirds of the shipping of European countries was built five years or more ago, and it has undergone not merely five years of ordinary wear, tear, and depreciation, but five years of the severest strain, of almost constant employment, with little or no opportunity for repairs and overhaul at regular intervals, with little of the usual care which the prudent and successful shipowner bestows constantly upon his fleet, and much of it still is bearing the scars of conflict.

During the fiscal year ended June 30, 1915, the total output of American shipyards was only 1,157 vessels of 225,122 gross tons, the smallest in 17 years, and of this total only 23 were over 1,000 gross tons, aggregating 127,844 gross tons. In the fiscal year ended June 30, 1916, the total was only 1,030 vessels of 347,147 gross tons. During the 12 months ended April, 1917, when we entered the war, we had built 683,725 gross tons of shipping, which was a record utput, and during April itself 79,045 gross tons. Near the end of that month the British war mission headed by Mr. Balfour and the French war mission headed by Mr. Viviani and Gen. Joffre visited Washington and, with other suggestions, expressed the hope that the United States could increase to 400,000 gross tons monthly its output of merchant ships, or at the rate of 4,800,000 gross tons a year. The full force of this request will appear when it is recalled that the world's largest previous output of ships launched was 3,332,882 gross tons in 1913.

The two following tables will show the progress made toward attaining the end desired by our allies.

The plainest way, perhaps, to show that progress, is to state the output for 12-month periods ending with each successive month for the period starting with June 30, 1916. The following statement in that form includes ships built in the United States for foreign owners which early in 1917 were becoming an important factor. The date in the ship's life chosen for the record is the date of the award of its official number, following some time after the launching, but in ordinary times shortly preceding the issue of the register. The rate of construction increased so rapidly during the war and delays in machinery were so frequent that awards for last year outstripped the registers by half a million tons.

| Month. | Seagoing. | | | | | | Grand total, including nonseagoing. | |
|---|---|---|---|---|---|---|---|---|
| | Steel. | | Wood. | | Total. | | | |
| | *No.* | *Gr. tons.* | *No.* | *Gr. tons.* | *No.* | *Gr. tons.* | *No.* | *Gr. tons.* |
| **1916.** | | | | | | | | |
| June | ...... | ........... | ...... | ........... | ...... | ........... | 1,030 | 347,147 |
| July | ...... | ........... | ...... | ........... | ...... | ........... | 1,012 | 361,313 |
| August | ...... | ........... | ...... | ........... | ...... | ........... | 1,042 | 398,671 |
| September | ...... | ........... | ...... | ........... | ...... | ........... | 1,057 | 424,058 |
| October | ...... | ........... | ...... | ........... | ...... | ........... | 1,086 | 476,922 |
| November | ...... | ........... | ...... | ........... | ...... | ........... | 1,124 | 537,683 |
| December | ...... | ........... | ...... | ........... | ...... | ........... | 1,179 | 555,262 |
| **1917.** | | | | | | | | |
| January | ...... | ........... | ...... | ........... | ...... | ........... | 1,230 | 603,449 |
| February | ...... | ........... | ...... | ........... | ...... | ........... | 1,258 | 606,881 |
| March | ...... | ........... | ...... | ........... | ...... | ........... | 1,314 | 630,508 |
| April | ...... | ........... | ...... | ........... | ...... | ........... | 1,367 | 683,726 |
| May | ...... | ........... | ...... | ........... | ...... | ........... | 1,445 | 713,071 |
| June | 114 | 468,502 | 80 | 131,449 | 194 | 599,951 | 1,546 | 812,659 |
| July | 124 | 513,567 | 84 | 143,778 | 208 | 657,345 | 1,630 | 871,080 |
| August | 128 | 537,804 | 93 | 152,765 | 221 | 690,569 | 1,681 | 904,354 |
| September | 132 | 547,325 | 100 | 162,646 | 232 | 709,971 | 1,688 | 942,516 |
| October | 130 | 553,975 | 115 | 184,287 | 245 | 738,262 | 1,693 | 962,989 |
| November | 129 | 538,206 | 123 | 192,515 | 252 | 730,721 | 1,701 | 949,601 |
| December | 142 | 605,738 | 137 | 211,830 | 279 | 817,568 | 1,699 | 1,034,296 |
| **1918.** | | | | | | | | |
| January | 144 | 607,404 | 137 | 211,626 | 281 | 819,030 | 1,657 | 1,025,496 |
| February | 157 | 682,867 | 146 | 222,723 | 303 | 905,590 | 1,669 | 1,106,093 |
| March | 180 | 759,354 | 153 | 238,051 | 333 | 997,405 | 1,670 | 1,194,127 |
| April | 203 | 845,338 | 157 | 236,498 | 360 | 1,081,836 | 1,668 | 1,278,132 |
| May | 232 | 966,850 | 151 | 219,947 | 383 | 1,186,797 | 1,661 | 1,381,369 |
| June | 252 | 1,031,976 | 158 | 215,716 | 410 | 1,247,692 | 1,622 | 1,430,793 |
| July | 275 | 1,124,066 | 189 | 274,330 | 464 | 1,398,396 | 1,610 | 1,571,572 |
| August | 315 | 1,268,452 | 214 | 354,172 | 529 | 1,622,624 | 1,612 | 1,781,379 |
| September | 352 | 1,411,144 | 256 | 465,327 | 608 | 1,876,471 | 1,681 | 2,013,264 |
| October | 396 | 1,594,927 | 287 | 546,613 | 683 | 2,141,540 | 1,760 | 2,280,111 |
| November | 437 | 1,771,560 | 331 | 657,487 | 768 | 2,429,047 | 1,814 | 2,500,503 |
| December | 460 | 1,861,321 | 361 | 735,705 | 821 | 2,597,026 | 1,882 | 2,721,281 |
| **1919.** | | | | | | | | |
| January | 490 | 1,982,372 | 392 | 810,194 | 882 | 2,792,566 | 1,957 | 2,920,832 |
| February | 520 | 2,094,236 | 404 | 850,415 | 924 | 2,944,651 | 2,008 | 3,074,661 |
| March | 538 | 2,178,939 | 436 | 916,037 | 974 | 3,094,976 | 2,056 | 3,225,521 |
| April | 582 | 2,364,479 | 451 | 947,117 | 1,033 | 3,311,596 | 2,092 | 3,438,076 |
| May | 626 | 2,558,249 | 458 | 965,643 | 1,084 | 3,523,892 | 2,157 | 3,639,089 |
| June | 656 | 2,725,196 | 481 | 1,021,020 | 1,137 | 3,746,216 | 2,241 | 3,860,494 |
| July | 691 | 2,908,309 | 476 | 1,004,072 | 1,167 | 3,912,381 | 2,293 | 4,028,181 |
| August | 728 | 3,117,735 | 462 | 948,206 | 1,190 | 4,065,941 | 2,354 | 4,187,670 |

## MONTHLY OUTPUT.

For the permanent record the monthly output of ships built and officially numbered and those built for foreigners is stated below for the past three fiscal years; the monthly output of 400,000 gross tons requested in May, 1917, was, in fact, attained within two years, and is temporarily the current rate of construction.

| Month. | Seagoing. | | | | | | Nonseagoing. | | Grand total. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Steel. | | Wood. | | Total. | | | | | |
| | *No.* | *Gr. tons.* | *No.* | *Gr. tons.* | *No.* | *Gr. tons.* | *No.* | *Gr. tons.* | *No.* | *Gr. tons.* |
| 1916. | | | | | | | | | | |
| July | 4 | 9,826 | 8 | 1,784 | 7 | 11,610 | 114 | 19,121 | 121 | 30,731 |
| August | 5 | 22,479 | 5 | 3,168 | 10 | 25,647 | 114 | 27,121 | 124 | 52,768 |
| September | 5 | 25,552 | 5 | 2,632 | 10 | 28,184 | 84 | 10,239 | 94 | 38,423 |
| October | 15 | 37,770 | 7 | 14,238 | 22 | 52,008 | 95 | 18,224 | 117 | 70,232 |
| November | 20 | 66,429 | 3 | 2,644 | 23 | 69,073 | 86 | 21,563 | 109 | 90,636 |
| December | 4 | 18,385 | 2 | 1,296 | 6 | 19,681 | 81 | 18,205 | 87 | 37,886 |
| Total | 53 | 180,441 | 25 | 25,762 | 78 | 206,203 | 574 | 114,473 | 652 | 320,676 |
| 1917. | | | | | | | | | | |
| January | 10 | 52,082 | 6 | 6,672 | 16 | 58,754 | 83 | 14,841 | 99 | 73,595 |
| February | 4 | 18,779 | 5 | 6,777 | 9 | 25,556 | 63 | 11,448 | 72 | 37,004 |
| March | 6 | 38,553 | 5 | 5,448 | 11 | 44,001 | 126 | 15,110 | 137 | 59,111 |
| April | 8 | 44,653 | 11 | 22,570 | 19 | 67,223 | 148 | 11,822 | 167 | 79,045 |
| May | 11 | 36,086 | 19 | 33,004 | 30 | 69,090 | 162 | 22,137 | 192 | 91,227 |
| June | 22 | 97,908 | 9 | 31,216 | 31 | 129,124 | 196 | 22,877 | 227 | 152,001 |
| Total | 61 | 288,061 | 55 | 105,687 | 116 | 393,748 | 778 | 98,235 | 894 | 491,983 |
| July | 14 | 54,891 | 7 | 14,113 | 21 | 69,004 | 184 | 20,148 | 205 | 89,152 |
| August | 9 | 46,716 | 14 | 12,155 | 23 | 58,871 | 152 | 27,171 | 175 | 86,042 |
| September | 9 | 35,073 | 12 | 12,513 | 21 | 47,586 | 80 | 28,999 | 101 | 76,585 |
| October | 13 | 44,420 | 22 | 35,879 | 35 | 80,299 | 87 | 10,386 | 122 | 90,685 |
| November | 19 | 50,660 | 11 | 10,872 | 30 | 61,532 | 87 | 15,736 | 117 | 77,268 |
| December | 17 | 85,917 | 16 | 20,611 | 33 | 106,528 | 52 | 16,053 | 85 | 122,581 |
| Total | 81 | 317,677 | 82 | 106,143 | 163 | 423,820 | 642 | 118,493 | 805 | 542,313 |
| Total, 1917 | 142 | 605,738 | 137 | 211,830 | 279 | 817,568 | 1,420 | 216,728 | 1,699 | 1,034,296 |
| 1918. | | | | | | | | | | |
| January | 12 | 53,748 | 6 | 6,468 | 18 | 60,216 | 39 | 4,579 | 57 | 64,795 |
| February | 17 | 94,242 | 14 | 17,874 | 31 | 112,116 | 53 | 5,485 | 84 | 117,601 |
| March | 29 | 115,040 | 12 | 20,776 | 41 | 135,816 | 97 | 11,329 | 138 | 147,145 |
| April | 31 | 130,637 | 15 | 21,017 | 46 | 151,654 | 119 | 11,396 | 165 | 163,050 |
| May [a] | [a] 40 | 157,598 | 13 | 16,453 | 53 | 174,051 | 132 | 20,413 | 185 | 194,464 |
| June | 42 | 163,034 | 16 | 26,985 | 58 | 190,019 | 130 | 11,406 | 188 | 201,425 |
| Total | 171 | 714,299 | 76 | 109,573 | 247 | 823,872 | 570 | 64,608 | 817 | 888,480 |
| July [b] | 37 | 146,981 | 38 | 72,727 | 75 | 219,708 | [b] 118 | 10,223 | 193 | 229,931 |
| August | 49 | 191,102 | 39 | 91,997 | 88 | 283,099 | 89 | 12,750 | 177 | 295,849 |
| September | 46 | 177,765 | 54 | 123,668 | 100 | 301,433 | 70 | 7,037 | 170 | 308,470 |
| October | 57 | 228,203 | 53 | 117,165 | 110 | 345,368 | 91 | 12,164 | 201 | 357,532 |
| November [c] | 60 | 227,293 | 55 | 121,746 | 115 | 349,039 | [c] 56 | 8,621 | 171 | 357,660 |
| December | 40 | 175,678 | 46 | 98,829 | 86 | 274,507 | 67 | 8,852 | 153 | 283,359 |
| Total | 289 | 1,147,022 | 285 | 626,132 | 574 | 1,773,154 | 491 | 59,647 | 1,065 | 1,832,801 |
| Total, 1918 | 460 | 1,861,321 | 361 | 735,705 | 821 | 2,597,026 | 1,061 | 124,255 | 1,882 | 2,721,281 |
| 1919. | | | | | | | | | | |
| January [d] | 42 | 174,799 | 37 | 80,957 | 79 | 255,756 | [d] 53 | 8,590 | 132 | 264,346 |
| February | 47 | 206,106 | 26 | 58,095 | 73 | 264,201 | 62 | 7,229 | 135 | 271,430 |
| March | 47 | 199,743 | 44 | 86,398 | 91 | 286,141 | 95 | 11,864 | 186 | 298,005 |
| April [e] | 75 | 316,177 | 30 | 52,097 | 105 | 368,274 | [e] 96 | 7,331 | 201 | 375,605 |
| May [f] | [f] 84 | 351,368 | 20 | 34,979 | 104 | 386,347 | 146 | 9,061 | 250 | 395,408 |
| June | 72 | 329,981 | 39 | 82,362 | 111 | 412,343 | 161 | 10,546 | 272 | 422,889 |
| Total | 367 | 1,578,174 | 196 | 394,888 | 563 | 1,973,062 | 613 | 54,621 | 1,176 | 2,027,683 |
| July [g] | 72 | 330,094 | 33 | 55,779 | 105 | 385,873 | [g] 140 | 11,755 | 245 | 397,628 |
| August [h] | 86 | 400,528 | [h] 25 | 36,131 | 111 | 436,659 | 127 | 18,679 | 238 | 455,338 |

[a] Includes 1 concrete vessel of 3,427 gross tons.
[b] Includes 1 concrete vessel of 325 gross tons.
[c] Includes 1 concrete vessel of 11 gross tons.
[d] Includes 3 concrete vessels of 1,004 gross tons.
[e] Includes 2 concrete vessels of 588 gross tons.
[f] Includes 1 concrete vessel of 2,481 gross tons.
[g] Includes 3 concrete vessels of 909 gross tons.
[h] Includes 1 concrete vessel of 2,795 gross tons.

The preceding pages have presented some of the main phases of the development of American shipping and shipbuilding during the war, but one must not hastily conclude therefrom we were impotent on the sea before the war and that the initiative and enterprise of our people had done nothing until over three billions of dollars were voted by Congress for shipping, starting June, 1917. Before it we were the third, now we are the second, maritime power. The war has enabled us to change places with Germany. The development of steel shipbuilding in the United States on a commercial basis, supplemented by the usual orders for warships from 1900 to July 1, 1917, when the great appropriations of Congress for ships became available was satisfactory, though not phenomenal, as shown by the following table of steel ships building or ordered at the beginning of each fiscal year since 1900:

| Date. | Merchant. | | | | | | Government. | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Great Lakes, etc. | | Seaboard. | | Total. | | | | | |
| | *No.* | *Gr. tons.* | *No.* | *Gr. tons.* | *No.* | *Gr. tons.* | *No.* | *Tons.*[a] | *No.* | *Tons.* |
| Aug. 15, 1900 | 20 | 70,119 | 48 | 207,561 | 68 | 277,680 | 47 | 113,329 | 115 | 391,009 |
| June 15, 1901 | 26 | 81,780 | 63 | 273,865 | 89 | 355,645 | 71 | 281,148 | 160 | 636,793 |
| July 1, 1902 | 39 | 124,537 | 65 | 222,949 | 104 | 347,486 | 67 | 269,890 | 171 | 617,376 |
| July 1, 1903 | 30 | 109,020 | 58 | 146,655 | 88 | 255,675 | 47 | 334,147 | 135 | 589,822 |
| July 1, 1904 | 1 | 400 | 56 | 94,588 | 57 | 94,988 | 38 | 331,435 | 95 | 426,423 |
| July 1, 1905 | 27 | 104,067 | 49 | 86,836 | 76 | 190,903 | 39 | 308,702 | 115 | 499,605 |
| July 1, 1906 | 33 | 175,472 | 78 | 159,299 | 111 | 334,771 | 29 | 237,814 | 140 | 572,585 |
| July 1, 1907 | 50 | 253,949 | 84 | 149,524 | 134 | 403,473 | 45 | 151,993 | 179 | 555,466 |
| July 1, 1908 | ...... | .......... | 13 | 14,775 | 13 | 14,775 | 82 | 136,091 | 95 | 150,866 |
| July 1, 1909 | 13 | 41,395 | 52 | 127,453 | 65 | 168,848 | 52 | 164,184 | 117 | 333,032 |
| July 1, 1910 | 36 | 59,692 | 63 | 86,075 | 99 | 145,767 | 45 | 184,096 | 144 | 329,863 |
| July 1, 1911 | 53 | 71,769 | 26 | 28,626 | 79 | 100,895 | 130 | 119,449 | 209 | 219,844 |
| July 1, 1912 | 51 | 78,353 | 80 | 192,960 | 131 | 271,313 | 85 | 234,923 | 216 | 506,236 |
| July 1, 1913 | 63 | 40,849 | 71 | 169,580 | 134 | 210,429 | 123 | 230,673 | 257 | 441,102 |
| July 1, 1914 | 17 | 39,337 | 24 | 104,631 | 41 | 143,968 | 58 | 142,910 | 99 | 286,878 |
| July 1, 1915 | 14 | 15,951 | 62 | 294,138 | 76 | 310,089 | 69 | 190,790 | 145 | 500,879 |
| July 1, 1916 | 175 | 228,345 | 210 | 997,439 | 385 | 1,225,784 | 60 | 79,802 | 445 | 1,305,586 |
| July 1, 1917 | 117 | 293,161 | 322 | 1,603,361 | 499 | 1,896,522 | ...... | .......... | ...... | .......... |

[a] Displacement.

## WORLD'S SHIPBUILDING 1911-1918.

Just as with tonnage afloat, some comparison of the shipbuilding in other countries is necessary to place in proper perspective the progress of American shipbuilding. Lloyd's figures for ships of over 100 gross tons launched during a period of years afford the only satisfactory standard of comparison, and those issued in February, 1919, show the tonnage launched annually since 1911, by countries, the tonnage except for the United States and Canada being practically all steel, and sail tonnage being less than 4 per cent of the total.

| Year. | United Kingdom. | | Dominions. | | Austria-Hungary. | | Denmark. | | France. | | Germany. | | Holland. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *No.* | *Tons.* | *No.* | *Tons.* | *No.* | *Tons.* | *No.* | *Tons.* | *No.* | *Tons.* | *No.* | *Tons.* | *No.* | *Tons.* |
| 1911...... | 772 | 1,803,844 | 62 | 19,662 | 16 | 37,836 | 18 | 18,689 | 79 | 125,472 | 154 | 255,532 | 113 | 93,050 |
| 1912...... | 712 | 1,738,514 | 84 | 34,790 | 12 | 38,821 | 22 | 26,103 | 80 | 110,734 | 165 | 375,317 | 112 | 99,439 |
| 1913...... | 688 | 1,932,153 | 91 | 48,339 | 17 | 61,757 | 31 | 40,932 | 89 | 176,095 | 162 | 465,226 | 95 | 104,296 |
| 1914...... | 656 | 1,683,553 | 80 | 47,534 | 11 | [a]34,335 | 25 | 32,815 | 33 | 114,062 | 89 | [a]387,192 | 130 | 118,153 |
| Total. | 2,828 | 7,158,064 | 317 | 150,325 | 56 | 172,749 | 96 | 118,539 | 281 | 526,353 | 570 | 1,483,267 | 450 | 414,938 |
| 1915...... | 327 | 650,919 | 31 | 22,014 | .... | ......... | 23 | 45,198 | 6 | 25,402 | .... | ........... | 120 | 113,075 |
| 1916...... | 306 | 608,235 | 40 | 31,571 | .... | ......... | 28 | 35,277 | 9 | 42,752 | .... | ........... | 201 | 180,197 |
| 1917...... | 286 | 1,162,896 | 105 | 94,471 | .... | ......... | 23 | 20,445 | 6 | 18,828 | .... | ........... | 146 | 148,779 |
| 1918...... | 301 | 1,348,120 | 206 | 279,904 | .... | ......... | 13 | 26,150 | 3 | 13,715 | .... | ........... | 74 | 74,026 |
| Total. | 1,220 | 3,770,170 | 382 | 427,960 | .... | ......... | 87 | 127,070 | 24 | 100,697 | .... | ........... | 541 | 516,077 |

| Year. | Italy. | | Japan. | | Norway. | | Sweden. | | United States. | | Other countries. | | World total. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *No.* | *Tons.* | *No.* | *Tons.* | *No.* | *Tons.* | *No.* | *Tons.* | *No.* | *Tons.* | *No.* | *Tons.* | *No.* | *Tons.* |
| 1911........ | 14 | 17,401 | 109 | 44,359 | 71 | 35,435 | 11 | 9,427 | 142 | 171,569 | 38 | 17,864 | 1,599 | 2,650,140 |
| 1912........ | 27 | 25,196 | 168 | 57,755 | 89 | 50,255 | 22 | 13,968 | 174 | 284,223 | 52 | 46,654 | 1,719 | 2,901,769 |
| 1913........ | 38 | 50,356 | 152 | 64,664 | 74 | 50,637 | 25 | 18,524 | 205 | 276,448 | 83 | 43,455 | 1,750 | 3,332,882 |
| 1914........ | 47 | 42,981 | 32 | 85,861 | 61 | 54,204 | 26 | 15,163 | 94 | 200,762 | 35 | [a] 36,148 | 1,319 | [a]2,852,753 |
| Total.. | 126 | 135,934 | 461 | 252,639 | 295 | 190,531 | 84 | 57,082 | 615 | 933,002 | 208 | 144,121 | 6,387 | 11,737,544 |
| 1915........ | 30 | 22,132 | 26 | 49,408 | 59 | 62,070 | 27 | 20,319 | 84 | 177,460 | 10 | [a] 13,641 | 743 | [a]1,201,638 |
| 1916........ | 10 | 56,654 | 55 | 145,624 | 52 | 42,458 | 34 | 26,769 | 211 | 504,247 | 18 | [a] 14,296 | 964 | [a]1,688,080 |
| 1917........ | 11 | 38,906 | 104 | 350,141 | 44 | 46,103 | 34 | 26,760 | 326 | 997,919 | 27 | [a] 32,538 | 1,112 | [a]2,937,786 |
| 1918........ | 15 | 60,791 | 198 | 489,924 | 51 | 47,723 | 36 | 39,583 | 929 | 3,033,030 | 40 | [a] 34,478 | 1,866 | [a]5,447,444 |
| Total.. | 66 | 178,483 | 383 | 1,085,097 | 206 | 198,554 | 131 | 113,431 | 1,550 | 4,712,656 | 95 | 94,953 | 4,685 | 11,274,948 |

[a] Returns not complete.

## CURRENT SHIPBUILDING.

On July 1, 1917, American shipyards had under construction, or contracted for by owners other than the Government of the United States, 499 steel vessels of 1,896,522 gross tons, a prospective output equal to the average prewar output of British yards. Soon after that date the American Government, through the Shipping Board, virtually took control of the yards and their output, and for the past two years shipbuilding has been almost wholly an enterprise of this Government. The new fiscal year opens under substantially the same conditions, as the shipyards are almost wholly occupied with the completion of the remainder of the construction program of the Shipping Board, amounting to upward of 4,500,000 gross tons and covering the calendar year 1920. The details of this program, of course, are covered by the reports of the Shipping Board, but the following summary has been furnished:

| Vessel. | Number. | Deadweight tons. | Approximate gross tons. |
|---|---|---|---|
| Steel ships.......................................................... | 926 | 6,357,707 | 4,400,000 |
| Wooden ships...................................................... | 311 | 784,048 | 520,000 |
| Concrete ships.................................................... | 14 | 84,000 | 56,000 |
| Total.................................................................. | 1,251 | 7,225,755 | 4,976,000 |

A few of the shipyards, however, have begun to accept private orders, and on July 1, 1919, such orders reported to this Bureau covered 16 steel ships of 83,910 gross tons. The best available returns of the shipbuilding in progress throughout the world on June 30, 1919, are those furnished by Lloyds' Register, covering a total of 8,017,767 gross tons, which may be compared with the largest prewar construction in progress, 3,445,000 gross tons on June 30, 1913:

| Country. | Steamers and motor vessels. | | | | Sailing vessels. | | | | Total. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Steel. | | Wood. | | Steel. | | Wood. | | | |
| | *Number.* | *Gross tonnage.* | *Number.* | *Gross tonnage.* | *Number.* | *Gross tonnage.* | *Number.* | *Gross tonnage.* | *Number.* | *Gross tonnage.* |
| United States: | | | | | | | | | | |
| Atlantic coast | 357 | 1,763,551 | 36 | 56,240 | 2 | 4,600 | 34 | 60,728 | 994 | 3,874,143 |
| Gulf ports | 34 | 141,340 | 53 | 126,300 | 1 | 4,500 | 31 | 68,983 | | |
| Pacific coast | 156 | 933,805 | 98 | 238,400 | | | 59 | 148,950 | | |
| Great Lakes | 133 | 326,746 | | | | | | | | |
| British Empire: | | | | | | | | | | |
| United Kingdom | 711 | 2,492,276 | 8 | 2,293 | 63 | 29,481 | | | 782 | 2,524,050 |
| Canada— | | | | | | | | | | |
| Great Lakes | 27 | 63,493 | | | | | | | 209 | 346,453 |
| Coast | 28 | 100,600 | 70 | 81,050 | 2 | 975 | 31 | 15,525 | | |
| Other dominions | 26 | 70,256 | 13 | 11,647 | | | 12 | 2,907 | | |
| Belgium | 4 | 7,063 | | | | | | | 4 | 7,063 |
| China | 7 | 33,300 | | | | | | | 7 | 33,300 |
| Denmark | 36 | 56,001 | 5 | 1,770 | | | | | 41 | 57,771 |
| France | 34 | 107,215 | 2 | 1,920 | | | 2 | 480 | 38 | 109,615 |
| Greece | 1 | 900 | 1 | 600 | | | | | 2 | 1,500 |
| Italy (including Trieste) | 42 | 243,940 | 35 | 21,605 | | | 19 | 6,075 | 96 | 271,620 |
| Japan | 63 | 282,060 | | | | | | | 63 | 282,060 |
| Netherlands | 88 | 219,332 | | | | | | | 88 | 219,332 |
| Norway | 40 | 55,586 | 24 | 6,855 | | | | | 64 | 62,441 |
| Portugal | | | | | | | 29 | 12,320 | 29 | 12,320 |
| Spain | 37 | 118,269 | | | | | 3 | 585 | 40 | 118,854 |
| Sweden | 42 | 88,650 | 19 | 7,155 | | | 8 | 1,440 | 69 | 97,245 |
| Total | 1,866 | 7,104,383 | 364 | 555,835 | 68 | 39,556 | 228 | 317,993 | 2,526 | [a]8,017,767 |

[a] Including 52 ferroconcrete vessels of 62,323 gross tons.

The foregoing table does not include shipbuilding in Germany, as the figures for that country are not yet available or important.

## SHIPPING LOSSES.

The losses of American shipping during the past five years have been 1,909 vessels of 1,122,725 gross tons, and, in addition, 3,431 vessels of 252,005 gross tons have been abandoned and stricken from the register. The following statement shows separately marine losses, war losses, and abandonments:

| | 1915 | | 1916 | | 1917 | | 1918 | | 1919 | | Total. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *No.* | *Gross tons.* | *No.* | *Gross tons.* | *No.* | *Gross tons.* | *No.* | *Gross tons.* | *No.* | *Gross tons.* | *No.* | *Gross tons.* |
| Marine losses | 301 | 123,590 | 337 | 128,209 | 345 | 110,264 | 409 | 180,497 | 372 | 217,414 | 1,764 | 759,974 |
| War losses | 3 | 8,792 | 2 | 8,084 | 22 | 71,382 | 75 | 180,502 | 43 | 93,991 | 145 | 362,751 |
| Total | 304 | 132,382 | 339 | 136,293 | 367 | 181,646 | 484 | 360,999 | 415 | 311,405 | 1,909 | 1,122,725 |
| Abandoned | 972 | 79,047 | 623 | 56,811 | 774 | 48,984 | 552 | 35,181 | 510 | 31,982 | 3,431 | 252,005 |
| Grand total | 1,276 | 211,429 | 962 | 193,104 | 1,141 | 230,630 | 1,036 | 396,180 | 925 | 343,387 | 5,340 | 1,374,730 |

The losses of merchant steamers of the principal maritime nations from August, 1914, to the armistice of November, 1918, according to Lloyds' Register, were as follows:

| Country. | War losses. | Marine losses. | Total. |
|---|---|---|---|
| | *Gross tons.* | *Gross tons.* | *Gross tons.* |
| United Kingdom | 7,753,311 | 1,032,779 | 8,786,090 |
| British Dominions | 169,712 | 99,866 | 269,578 |
| American | 343,090 | 187,948 | 531,038 |
| Belgian | 85,842 | 19,239 | 105,081 |
| Brazilian | 20,328 | 10,951 | 31,279 |
| Danish | 210,880 | 34,422 | 245,302 |
| Dutch | 201,797 | 27,244 | 229,041 |
| French | 722,939 | 84,138 | 807,077 |
| Greek | 349,661 | 65,014 | 414,675 |
| Italian | 745,766 | 115,669 | 861,435 |
| Japanese | 119,764 | 150,269 | 270,033 |
| Norwegian | 976,516 | 195,244 | 1,171,760 |
| Spanish | 157,527 | 80,335 | 237,862 |
| Swedish | 180,415 | 83,586 | 264,001 |
| Total | 12,037,548 | 2,186,704 | 14,224,252 |

The marine casualties of steamers were only a trifle above the average, as for the five years from 1909 to 1913, inclusive, they aggregated 2,160,346 gross tons. When it is recalled that for nearly five years in European waters ships ran at night much of the time without lights, and that for part of this period they ran across the Atlantic and along our own coasts without these precautionary signals, the comparative results are a high tribute to the vigilance and skill of the masters and deck officers of the ships. That the losses from both causes were not greater is also due, first, to naval convoys and, second, to the courage and endurance of officers and men who brought many stricken ships to port which under ordinary conditions would have been justifiably abandoned at sea, and did, doubtless, appear in German statements of submarine ruthlessness. During the four years and four months of war the total losses were 14,224,252 gross tons of steamers. During the five calendar years covering that period the world's output of ships was 14,127,701 gross tons, of which less than 3 per cent were sailing vessels.

The effect of war, however, went beyond the mortality among ships, for many vessels which under ordinary conditions would have been broken up and sold as junk were patched up and are included in the world's outstanding tonnage. The world's merchant tonnage afloat to-day, as already shown, is greater than ever before, and undoubtedly would more than suffice to conduct the world's diminished foreign commerce consequent upon diminished production and vast national debts, if it were as efficient as the tonnage of 1914. Allowances for the customary growth of merchant shipping in ordinary times are quite out of place under present conditions, for such growth is based on increased ocean trade and increased international exchanges of products by sea. There has been no such increase, and there can not be until production has become at least normal abroad as well as at home. Freights must be higher than usual, because under present conditions the European countries with which we fought side by side have not yet been able, through death and devastation, to supply the usual return cargoes of their own production with which to pay for the products of countries remote from the scene of conflict. The outward cargo, accordingly, pays to a much greater extent than usual the entire charges of the ship's round voyage, and those charges fall, of course, upon the consumer. The interruptions of commerce through strikes on shipboard and along the docks, through the congestion of freight at seaports of lading and discharge, and through like extraneous causes reduce still further the inherent relative inefficiency of the ships afloat.

### ACTIVITY OF SHIPPING.

The statements on the preceding pages have dealt with the gross tonnage of ships and its growth since the outbreak of the war early in August, 1914. The activity of those ships, the part they were actually taking in the foreign trade of the United States before the war, and the part they have taken since are shown by the clearances for foreign ports. Clearances are stated in net tons (the net ton being 100 cubic feet available for cargo or passengers), and if a ship clears more than once during a year its net tonnage, of course, will reappear in the total for the year as many times as it departs on a voyage. Attention at the present time is centered on ships on the longer voyages between the United States and Europe, Africa, Asia, Oceania, and South America rather than on those ships which make frequent voyages to the near-by ports of North and Central America, Mexico, and the West Indies. The total net tonnage of all ships, American and foreign, steam and sail, which cleared from the United States for the other continents, during the fiscal years ended June 30, 1914, the year before the war; 1918, the complete year of our participation in the war; and 1919, the year of our maximum effort, of the armistice, and of a partial resumption of commerce, is as follows:

| To— | 1914 | 1918 | 1919 |
|---|---|---|---|
| Europe | 16,144,118 | 14,263,547 | 16,431,123 |
| South America | 2,429,659 | 2,237,976 | 2,705,365 |
| Asia and Oceania | 1,990,105 | 2,095,324 | 2,529,998 |
| Africa | 406,457 | 235,649 | 393,971 |
| Total | 20,970,339 | 18,832,496 | 22,060,457 |

During 1918, of course, there were no clearances for German ports, and during 1919 only 9,734 net tons; so clearances for Germany are excluded, which in 1914 aggregated 3,902,073 net tons. During 1918 and 1919, however, the movement of troops, munitions, and supplies called for a net tonnage of transports, not required to clear, larger than the net tonnage which before the war cleared for German ports. In fact, therefore, the ships which left American ports for the continents across the sea during the past two fiscal years were of greater net tonnage than in any previous year.

The total shipping facilities for trade between the United States and Europe, as shown by actual voyages, accordingly, were substantially equal to the facilities of 1914. But the share of American ships in the totals just stated reflects the increase in American shipping and shipbuilding already indicated. The clearance figures are always a more useful indication of the participation of our ships in foreign trade than are percentages of the money value of exports and imports carried in such ships, especially in these times of inflated prices. The following statement shows the net tonnage of American ships included in the total net tonnages just stated for 1914, 1918, and 1919:

ing months ended July 31, 1194, and in trade with Europe that tonnage had decreased one-third. The situation thus does not arise in Great Britain from lack of ships, but from lack of outward cargoes and other causes. The situation is of importance not only to American shipping and shipbuilding, but equally so to American foreign trade and domestic production. Foreign trade is, of course, a direct or indirect exchange of products, and its successful and economical conduct, so far as ships are involved, depends on cargoes both outward and homeward, so that the ship all the time may be earning money, not spending it, as when it sails in ballast.

### COAL AND OIL.

British trade and shipping for years were developed, looking only at the material side of it, on the production of an excess of coal for export beyond domestic demands. During the seven months ended July 31, 1914, covered by the clearance table above, the exports of coal (including coke, etc.) from the United Kingdom amounted to 43,000,000 tons, and 12,000,000 additional tons were despatched for ships' fuel. During the seven months since January 1, 1919, the coal exports were only 23,675,000 tons, and only 6,815,000 tons were exported in the form of ships' fuel, a decline of over 25,000,000 tons in all and of 19,500,000 tons in coal as cargo. As a net ton of shipping 100 cubic feet will hold about two tons of coal, the deficit in cargo is equivalent to nearly 10,000,000 net tons of shipping. The clearances of British ships with cargoes was 9,676,000 net tons less during the seven months of 1919 than for the same seven months in 1914, and for all ships 17,000,000 net tons less. The world's loss of torpedoed passenger ships has not yet been made good, and though coal is the largest and bulkiest article of ocean commerce, manufactured goods have, of course, a large part in the British export trade. The product of the coal mines of the United Kingdom for 1914 was 265,664,000 tons, and the product for 1919, on the basis of the output thus far, is estimated at 228,000,000 tons, a decline of 37,600,000 tons, equivalent to cargoes for clearances of ships during the year aggregating about 19,000,000 net tons, approaching an equivalent of the total overseas clearances from the United States during the past fiscal year. Whether the British coal industry is again to become a normal factor in ocean trade, or to become the greatest suicide club on record, is thus one of the considerable elements in the determination of plans for the employment and future of an American merchant marine, for it affects the type of ships to be built, the ports to which they can profitably ply, the financial arrangements at home and abroad which steamship companies and exporters should make, and even the directions in which capital and labor should turn for the most satisfactory employment.
he impression, probably, is no longer general that there is a shortage
apphipping and still a demand for "more ships" merely as ships,
by dless of type. We have every reason to be satisfied with the
r in which the country responded to that urgent prayer in
917, but the problem directly ahead of us is one of ship
of the activity of our own and foreign ships.

The only erse of the British situation in respect of coal is the
appropriatio -export situation. The United States is the largest
in view of the

exporter of oil, which in the world's navies and passenger ships is rapidly taking the place of coal as fuel, and as fuel for cargo boats offers such advantages and economies to the steel ships built in the United States during the past three years, a large percentage of which burn oil, as to offset structural disadvantages inevitable from the haste with which they were built.

The increasing use of oil as ships' fuel tells to our advantage in that oil requires a considerably less number of men in the fireroom than does coal, and the work is less arduous. During the past two years so many of our merchant ships, or ships which are going into trade upon the close of their service as transports or munitions and supply ships, have been manned by enlisted men in the Navy or Naval Reserves that the limited number of our seafaring men has not yet been brought home to us, as it necessarily will be during the current fiscal year. In this respect our disadvantage increases with the growth of our tonnage, while competing nations, which have lost more heavily in tonnage than in crews to man their ships, have an advantage. The use of oil as fuel, accordingly, is in part an offset, especially as in normal times the fireroom force is more highly paid than the deck force, and the relative difference there in American and foreign wages is greater. The economic rule that, other things being equal, the harder and more disagreeable work will be better paid can not arbitrarily be set aside indefinitely, and as it asserts itself the advantage which oil as a fuel gives to the American ship will show itself. There is a like advantage in this respect in the production as in the consumption as fuel on shipboard of oil compared with coal.

The export of oil as cargo, however, differs from the export of coal, because the tanker carrying out oil in bulk necessarily returns in ballast or with a very small amount of cargo. There seems to be no reason why the United States should not permanently excel in the construction and operation of this type of ship not only in the export trade of the United States, but also in that of Mexico and other portions of this hemisphere, in which oil may be found in abundance. Any handicaps, at least, will be of our own invention, as our natural advantages for the development of this element in a merchant marine are evident, and the present is plainly the opportune time.

## ADMINISTRATIVE SITUATION.

The increase in ships and shipbuilding since 1914, and especially during the past fiscal year, had not up to June 30, 1919, created serious administrative difficulties, for two reasons: First, because for the past two years we were at war and in nearly all branches of Government activity, certainly in shipping, the ancient adage "Inter arma silent leges" has prevailed; second, the Government itself has
assumed control of and operated the greater part of American sab-
going shipping as a military measure, manned with its enlisted rican
about 600 of our ships, and on June 30 last was the actual opping
of about half the 7,300,000 gross tons comprising the seagoir always
of larger vessels (over 1,000 gross tons) under the flag, and foreign
the Government was entitled to, and frequently claimed and imports
prerogative, exemption from laws. prices. The
ships included
and 1919:

The war, however, is ended, and, if the operation of the mercantile marine on commercial principles in accord with acts of Congress is to be resumed, the men and the money needed to administer those acts should be provided to meet the great increase in American shipping. To illustrate, the American seagoing ships of over 1,000 gross tons on June 30, 1914, numbered 755 of 2,128,731 gross tons, and for that fiscal year the total appropriations for the shipping commissioners' service was $71,350 and the number of men employed was 48. On July 1, 1919, the large seagoing ships numbered 2,058 of 7,300,122 gross tons, and are increasing at the rate of 400,000 gross tons a month, while the total appropriations for the current year for the shipping commissioners' service was $88,465, and the number of men employed was 59. Already it has been necessary to ask for a deficiency appropriation and more men, and until they have been obtained the Bureau has had to ask the Panama Railroad Steamship Co. and the Shipping Board to assign some of their employees to shipping commissioners' offices to help in the despatch of their ships, respectively. This is not economy, nor good administration, nor compliance with the spirit of the laws and ought not to continue, but it is better than adding one more source of delay to the outward movement of ships.

## RADIO COMMUNICATION.

The situation as to the administration of the laws regulating radio communication is even more disheartening. On June 30, 1915, there were 585 American ships with licensed wireless stations, and 1,653 commercial radio operators had been examined and licensed to operate them. For that year the appropriations for the wireless service were $45,000, and the inspectors and others employed numbered 26. On July 1, 1919, the number of American ships equipped with wireless numbered 2,312 and is increasing monthly with the increase of tonnage mentioned at the rate of about 100 a month. During July and August alone 714 operators were examined and licensed, but the appropriation remains at $45,000, as in 1915, and the inspectors and others employed number 29. Two branches of the work of the radio service have been mentioned which admit of comparative statement in figures. The exigencies of war developed the wireless art, as it developed flying, with which to an extent it is already related, and the development was in communication by land, as well as by sea. Unless the radio-inspection service is to keep pace with the improvements and inventions of the art, the Government would do better to withdraw altogether from the field of inspection. To keep pace with developments, the Government ought to retain those men who in its armies in France and in other services have themselves contributed to those developments and have applied them. It has been necessary to ask for a deficiency appropriation and more men and the best men shown to be such by demands the war made on their skill and ingenuity.

## TONNAGE ADMEASUREMENT.

The only reason why it is not necessary to ask for a deficiency appropriation to carry out the laws for the admeasurement of ships in view of the multiplication of our tonnage is because the Shipping

Board building program, which almost exclusively occupied our yards last year and will continue to do so during the current fiscal year, comprises only a few types of ships of fixed general dimensions, and the blue prints for one ship will serve to give instructions for the admeasurement of scores of ships like it. In time we shall probably return, possibly by next year, to the normal method of building ships, particularly with a view to the needs of our commerce and the varying types and numbers of ships required to meet them. When that time comes, if our shipbuilding industry retains the major part of the advantages it has derived from great expenditures from the Treasury, appropriations for admeasuring ships and the establishment of a body of measurers, more uniformly qualified for the work will be needed. The work is now done by men in the marine divisions in the customhouses, some of whom are experienced men, abundantly qualified, who can give their time to the work, while others are drawn for short periods from desks where they compute tariff figures or compile statistical returns. To secure uniform practice by oral instruction and demonstration, only one adjuster is provided at $3,500 to cover salary, traveling, and all other expenses.

## LOADLINES.

The enactment of the bill providing for loadlines for ships now pending in both branches of Congress will require a staff of men competent to give it effect, some at Washington and some at the principal seaports. The questions involved relate both to the safety of the ship and those on board and to commercial competition on just and equal terms with the ships of other nations, and cheap men can not do the work. The details of estimates and force are reserved, of course, until the passage of the bill, but the subject is mentioned because our increase in tonnage and its voyages to all parts of the world call for the creation of administrative agencies similar to those which other nations have found necessary.

## BULKHEADS.

Akin to the subject of loadline for cargo ships is the subject of bulkheads and other structural features of passenger ships, which like loadlines, is related both to the safety of the ship and those on board and to equitable conditions of commercial competition.

The possession of 13,000,000 gross tons of shipping under the flag, of which 7,300,000 gross tons are seagoing ships of over 1,000 gross, and a possible increase of almost 4,000,000 gross tons during the current year, is no more in itself a merchant marine approaching that under the British flag, and much greater than that ever under any other flag, than was the mere draft of about 11,000,000 men last year the creation of the largest and best army in history. The assemblage of the material as of the men was only the first part of the undertaking. Some of the administrative details relating to ships are mentioned on the assumption that Congress does not intend as a permanent policy to vote public money to build all the ships and to operate a large percentage of them.

## STATISTICS FOR THE YEARS 1918 AND 1919.

The following table shows the geographical distribution, motive power and material of construction, and trade of vessels of the United States and details of construction for the fiscal years 1918 and 1919:

### COMPARISON OF AMERICAN MERCHANT MARINE OF 1918 AND 1919.

### TOTAL MERCHANT FLEET.

| Classification. | 1918 | | 1919 | |
|---|---|---|---|---|
| | *Number.* | *Gross tons.* | *Number.* | *Gross tons.* |
| GEOGRAPHICAL DISTRIBUTION. | | | | |
| Atlantic and Gulf coasts | 16,327 | 5,356,976 | 16,596 | 6,945,260 |
| Pacific coast | 5,755 | 1,646,697 | 6,198 | 2,816,481 |
| Northern lakes | 2,939 | 2,797,503 | 3,043 | 3,023,762 |
| Western rivers | 1,690 | 123,342 | 1,676 | 121,797 |
| Total | 26,711 | 9,924,518 | 27,513 | 12,907,300 |
| POWER AND MATERIAL. | | | | |
| **Sail:** | | | | |
| Wood | 4,422 | 900,542 | 4,102 | 903,430 |
| Metal | 165 | 308,993 | 158 | 296,231 |
| Total | 4,587 | 1,209,535 | 4,260 | 1,199,661 |
| **Steam:** | | | | |
| Wood | 4,233 | 823,823 | 4,300 | 1,320,578 |
| Metal | 2,534 | 6,313,690 | 3,097 | 8,736,822 |
| Total | 6,767 | 7,137,513 | 7,397 | 10,057,400 |
| **Gas:** | | | | |
| Wood | 9,775 | 275,494 | 10,126 | 299,726 |
| Metal | 116 | 58,307 | 128 | 58,501 |
| Total | 9,891 | 333,801 | 10,254 | 358,227 |
| Canal: | | | | |
| Wood | 519 | 58,588 | 489 | 56,137 |
| Metal | | | 1 | 294 |
| Total | 519 | 58,588 | 490 | 56,431 |
| Barges: | | | | |
| Wood | 4,705 | 1,051,726 | 4,832 | 1,091,576 |
| Metal | 242 | 133,355 | 280 | 144,005 |
| Total | 4,947 | 1,185,081 | 5,112 | 1,235,581 |
| Grand total | 26,711 | 9,924,518 | 27,513 | 12,907,300 |
| TRADE. | | | | |
| Registered: | | | | |
| Sail— | | | | |
| Wood | 506 | 337,335 | 637 | 413,126 |
| Metal | 49 | 83,110 | 49 | 86,419 |
| Total | 615 | 420,445 | 686 | 499,545 |
| Steam— | | | | |
| Wood | 269 | 113,084 | 432 | 547,393 |
| Metal | 657 | 2,750,055 | 1,236 | 5,268,232 |
| Total | 926 | 2,863,139 | 1,668 | 5,815,625 |
| Gas— | | | | |
| Wood | 1,132 | 112,529 | 1,295 | 139,623 |
| Metal | 21 | 40,113 | 21 | 38,957 |
| Total | 1,153 | 152,642 | 1,316 | 178,580 |
| Barges— | | | | |
| Wood | 1,295 | 151,116 | 1,337 | 157,511 |
| Metal | 24 | 16,364 | 25 | 18,465 |
| Total | 1,319 | 167,480 | 1,362 | 175,976 |
| Total registered | 4,013 | 3,603,706 | 5,032 | 6,669,726 |

## COMPARISON OF AMERICAN MERCHANT MARINE OF 1918 AND 1919—Continued.

| Classification. | 1918 | | 1919 | |
|---|---|---|---|---|
| | *Number.* | *Gross tons.* | *Number.* | *Gros tons.* |
| TRADE—continued. | | | | |
| Enrolled and licensed: | | | | |
| Sail— | | | | |
| Wood | 3,856 | 563,207 | 3,465 | 490,304 |
| Metal | 116 | 225,883 | 109 | 209,812 |
| Total | 3,972 | 789,090 | 3,574 | 700,116 |
| Steam— | | | | |
| Wood | 3,964 | 710,739 | 3,868 | 773,185 |
| Metal | 1,877 | 3,563,635 | 1,861 | 3,468,590 |
| Total | 5,841 | 4,274,374 | 5,729 | 4,241,775 |
| Gas— | | | | |
| Wood | 8,643 | 162,965 | 8,831 | 160,103 |
| Metal | 95 | 18,194 | 107 | 19,544 |
| Total | 8,738 | 181,159 | 8,938 | 179,647 |
| Canal— | | | | |
| Wood | 519 | 58,588 | 489 | 56,137 |
| Metal | | | 1 | 294 |
| Total | 519 | 58,588 | 490 | 56,431 |
| Barges— | | | | |
| Wood | 3,410 | 900,610 | 2,495 | 934,065 |
| Metal | 218 | 116,991 | 255 | 125,540 |
| Total | 3,628 | 1,017,601 | 2,750 | 1,059,605 |
| Total enrolled and licensed | 22,698 | 6,320,812 | 22,481 | 6,237,574 |
| Grand total | 26,711 | 9,924,518 | 27,513 | 12,907,369 |

## VESSELS BUILT DURING FISCAL YEARS 1918 AND 1919.

| | | | | |
|---|---|---|---|---|
| GEOGRAPHICAL DISTRIBUTION. | | | | |
| Atlantic and Gulf coasts | 708 | 562,000 | 861 | 1,452,230 |
| Pacific coast | 517 | 518,437 | 668 | 1,363,503 |
| Northern lakes | 168 | 215,022 | 317 | 507,172 |
| Western rivers | 135 | 5,409 | 107 | 3,716 |
| Total | 1,528 | 1,300,868 | 1,953 | 3,326,621 |
| POWER AND MATERIAL. | | | | |
| Sail: | | | | |
| Wood | 112 | 78,894 | 83 | 77,687 |
| Metal | 3 | 4,735 | 1 | 1,547 |
| Total | 115 | 83,629 | 84 | 79,234 |
| Steam: | | | | |
| Wood | 80 | 37,771 | 651 | 2,117,492 |
| Metal | a 229 | 962,547 | 240 | 989,572 |
| Total | 309 | 1,000,318 | 891 | 3,107,064 |
| Gas: | | | | |
| Wood | 612 | 85,932 | 626 | 48,965 |
| Metal | 8 | 4,746 | 7 | 1,062 |
| Total | 620 | 90,678 | 633 | 50,027 |
| Canal: | | | | |
| Wood | 32 | 4,101 | 15 | 2,731 |
| Metal | | | | |
| Total | 32 | 4,101 | 15 | 2,731 |
| Barges: | | | | |
| Wood | 437 | 113,969 | 307 | 80,791 |
| Metal | 15 | 8,173 | b 23 | 6,774 |
| Total | 452 | 122,142 | 330 | 87,565 |
| Total construction | 1,528 | 1,300,868 | 1,953 | 3,326,621 |

a Including 1 concrete steam vessel of 3,427 gross tons.
b Including 4 concrete barges of 1,231 gross tons.

The following summary of vessels of 1,000 gross tons
the preceding table and of such vessels built other fiscal
the beginning of the war shows changes in the larg
construction:

| Type. | 1915 | | 1916 | | 1917 | | 1918 | |
|---|---|---|---|---|---|---|---|---|
| | *No.* | *Gross tons.* | *No.* | *Gross tons.* | *No.* | *Gross tons.* | *No.* | *Gross tons.* |
| Seaboard: | | | | | | | | |
| Ocean steel steamers | 18 | 111,625 | 35 | 187,128 | 47 | 300,290 | 145 | 813,8 |
| Ocean steel gas screws | .... | ........ | .... | ........ | 4 | 13,009 | .... | ........ |
| Steel ferryboats, river and bay steamers | 1 | 1,402 | 2 | 3,362 | 3 | 5,363 | .... | ........ |
| Wooden steamers | 1 | 5,373 | 1 | 1,103 | 13 | 17,600 | 17 | 30,9 |
| Wooden gas screws | .... | ........ | .... | ........ | 9 | 15,121 | 34 | 68,0 |
| Steel schooners | .... | ........ | .... | ........ | 1 | 1,432 | 2 | 3,0 |
| Wooden schooners | 1 | 1,318 | 7 | 11,286 | 14 | 20,212 | 40 | 58,0 |
| Wooden barkentines | .... | ........ | .... | ........ | 1 | 1,220 | .... | ........ |
| Wooden unrigged vessels | .... | ........ | .... | ........ | 1 | 1,357 | 1 | 1,0 |
| Total | 21 | 119,718 | 45 | 202,879 | 93 | 375,604 | 239 | 975,1 |
| Great Lakes: | | | | | | | | |
| Steel steamers, lake trade | 1 | 6,331 | 5 | 26,876 | 14 | 94,715 | 6 | 43,0 |
| Steel steamers, ocean trade | 1 | 1,815 | 6 | 10,915 | 10 | 21,790 | 83 | 180,8 |
| Steel gas screws, ocean trade | .... | ........ | .... | ........ | 6 | 11,793 | 2 | 4,2 |
| Steel schooner-barges, ocean trade | .... | ........ | .... | ........ | 1 | 2,320 | 1 | 2,3 |
| Total | 2 | 8,146 | 11 | 37,791 | 31 | 130,618 | 92 | 230,5 |
| Western Rivers: | | | | | | | | |
| Steel gas screws | .... | ........ | 1 | 1,473 | .... | ........ | .... | ........ |
| Steel barge | .... | ........ | .... | ........ | .... | ........ | 1 | 1,3 |
| Grand total | 23 | 127,864 | 57 | 242,143 | 124 | 506,222 | 332 | 1,207,0 |

## SUMMARY AND TYPES OF SHIPS OF 1,000 GROSS TON

Practically all this tonnage was built for salt water, an
of it for the foreign trade. According to place of build
vessel the ships above may be thus summarized:

| Type. | Seaboard. | | Great Lakes. | |
|---|---|---|---|---|
| | *No.* | *Gross tons.* | *No.* | *Gross tons.* |
| Steel steamers | 381 | 2,037,916 | 206 | 492,469 |
| Wooden steamers | 208 | 556,900 | ...... | .......... |
| Steel schooner | 1 | 1,547 | ...... | .......... |
| Wooden schooners | 33 | 48,299 | ...... | .......... |
| Wooden barkentine | 1 | 1,393 | ...... | .......... |
| Wooden gasoline | 14 | 28,554 | ...... | .......... |
| Total | 638 | 2,674,609 | 206 | 492,469 |

## SHIPPING COMMISSIONERS.

Summaries of the routine work of shipping commissio
past fiscal year are printed as usual in Appendix A.
increase in our merchant shipping, especially on trans-A
ages, is not reflected in these summaries because the
ships and the war created wholly abnormal conditions,
not begin to disappear until near the end of May. Abou
owned or requisitioned by the Shipping Board, accord
estimate of the Navy Department, were supplied wit
enlisted men of the U. S. Navy, and were under comman

of the U. S. Navy, numbering in all 120,000. This number, however, includes gun crews that were put on board ships manned by regular merchant crews. These enlisted men of the U. S. Navy served and were paid under their enlistment papers and, of course, did not appear before the shipping commissioners for shipment and discharge. Part of these 120,000 were employed on the seized German ships and other merchant ships assigned to the Army and Navy for transport service; but, accepting the Navy estimates of 120,000 men supplied to merchant ships, more than half of the additional work imposed by law on the shipping commissioners under normal conditions was performed as a war-emergency measure by the Navy Department. The gradual discharge of naval crews and the shipment of merchant crews began in May, and on August 1 fully 1,500 enlisted naval radio operators were withdrawn from merchant ships. Instead of a gradual increase in the force of the shipping commissioners' offices needed to perform their increase of work in consequence of the steady increase in our merchant shipping, the force should be increased at once to meet the transition from war to peace conditions. Our shipping is increasing at the rate of nearly 400,000 gross tons a month. For these reasons it has been necessary to ask for a deficiency appropriation for the current year and in the estimates for next year to ask provision for an enlarged force.

Besides the volume of work, the nature of the work of these officers has changed considerably. So long as our ships were employed chiefly in the coastwise or near-by foreign trades, members of crews were in fairly close touch with their families and dependents, but since American ships in increasing numbers are visiting the remote ports of the world the shipping commissioners' offices have to answer numerous inquiries from relatives and dependents as to the whereabouts of seamen. There ought to be established in all the commissioners' offices at least a card index of seamen—a plan favored by the Bureau for some time, but impossible of performance during war conditions—and a registry of seamen in the Bureau of Navigation, similar to the British registrar of merchant seamen, would be desirable. The difficulty which both propositions face is the very large alien element in our merchant crews, many of whom have no fixed home here, often deserting from foreign ships in our ports in order to join American ships bound to their own countries or elsewhere about the world as inclination or circumstances may suggest. On the other hand, we have undoubtedly a considerable maritime population which retains its allegiance to other countries, but has its home in the United States serving on American ships on account of the higher pay which always has been paid and the better conditions which always have been afforded. Such considerable and unavoidable increases in appropriations must be requested at a time when rigid economy is incumbent upon all that the subject of registration even of American seamen owing allegiance to the United States and with homes here may perhaps be deferred until next year.

The shipping commissioners are designated by statute to hear and decide any question between the master, consignee, agent, or owner, and any of the crew which may be submitted to them by both parties to a dispute and the decision is deemed conclusive as to the rights of the parties before a court of justice. During the war various agencies outside the statutes were created which dealt with the general relations of employers and employees and were necessary, as the Government itself stood in the relation of employer to those employed in many of the essential industries and occupations of the country. General rulings of these agencies, so far as applicable, were observed by shipping commissioners, so far as I am aware, but the number of individual issues to be determined by the statutory officers in the shipping service was not thereby reduced. The discretionary powers vested by Congress in these officers since 1872, and the extent to which they are invoked, suggest a higher range of salaries than those awarded to them before 1914 and remaining substantially unchanged. This consideration is entirely apart from all questions of the higher cost of living, which, however, with everyone else in the country, they must meet. It is based on the nature of work requiring judgment which Congress has imposed for nearly 50 years on these officers and the vast appropriations by Congress for ships in the past three years have greatly increased.

## MEN SHIPPED AND DISCHARGED.

During the year 485,796 officers and men have been shipped, reshipped, or discharged by shipping commissioners, compared with 457,248 during the previous fiscal year. These figures include the repeated shipments in many cases of the same men on different voyages, and often on different ships, and are not to be taken as a statement of the number of different officers and men who manned our ships and were under the commissioner's supervision as to their contracts which was approximately between 85,000 and 90,000.

The following statement shows the aggregate routine work and salaries of commissioners and their force for the past decade:

| Year. | Seamen shipped, reshipped, and discharged. | Salaries. | Average cost per man. | Year. | Seamen shipped, reshipped, and discharged. | Salaries. | Average cost per man. |
|---|---|---|---|---|---|---|---|
| 1910 | 356,448 | $65,539.19 | $0.18 | 1915 | 414,744 | $63,755.47 | $0.15 |
| 1911 | 367,023 | 67,155.90 | .18 | 1916 | 487,524 | 62,637.45 | .13 |
| 1912 | 374,783 | 63,373.53 | .17 | 1917 | 506,941 | 66,211.83 | .13 |
| 1913 | 379,188 | 62,374.13 | .16 | 1918 | 457,248 | 72,075.48 | .16 |
| 1914 | 378,772 | 63,475.20 | .17 | 1919 | 485,796 | 75,288.47 | .15 |

## NATIONALITY OF CREWS.

The change in the nationality of officers and men of our merchant ships during the war is the result of several forces operating at different times. Upon our declaration of war in April, 1917, many officers and men of the American merchant marine joined as volunteers the United States Naval Reserves and served with credit and often distinction. But with the increase in merchant tonnage this withdrawal was felt severely, and regulations under the draft, accordingly, allowed men in the merchant service to choose between joining the Army or remaining in the merchant service, which prevented a further drain on our merchant marine personnel and attracted others to ship. Congress also voted to the Shipping Board $6,250,000 for recruiting, instructing, and training officers, engineers, and crews for

American vessels and for all expenditures incidental thereto. The resultant of these forces has been a considerable increase in the proportion of American citizens, native-born and naturalized, who were shipped before shipping commissioners, and for the past year the percentage of such is 47.6, a restoration to the percentage of 47.4 in 1914. The following table shows the nationality of those shipped (counting repeated shipments) of officers and men before shipping commissioners during the past eight years:

| Nationality. | 1912 | 1913 | 1914 | 1915 | 1916 | 1917 | [a] 1918 | 1919 |
|---|---|---|---|---|---|---|---|---|
| Americans (born) | 58,109 | 63,040 | 63,247 | 65,196 | 76,956 | 81,899 | 72,613 | 97,160 |
| Americans (naturalized) | 35,562 | 32,780 | 31,417 | 29,965 | 31,877 | 26,826 | 24,868 | 24,676 |
| British | 21,033 | 24,031 | 24,745 | 29,395 | 29,523 | 28,947 | 26,967 | 26,848 |
| Chinese | 55 | 65 | 64 | 471 | 68 | 42 | 205 | 729 |
| Japanese | 290 | 193 | 98 | 200 | 245 | 368 | 972 | 1,198 |
| Filipinos | 184 | 258 | 472 | 482 | 528 | 650 | 1,091 | 1,154 |
| Germans | 7,185 | 9,185 | 9,497 | 9,466 | 12,415 | 10,254 | 206 | 138 |
| Norwegians | 9,394 | 8,679 | 8,194 | 9,891 | 11,383 | 9,819 | 9,617 | 10,237 |
| Swedes | 7,565 | 6,995 | 6,321 | 7,878 | 9,208 | 9,505 | 10,095 | 10,054 |
| Danes | 2,744 | 2,510 | 2,260 | 4,084 | 4,608 | 4,893 | 5,467 | 5,843 |
| Russians | 4,403 | 4,483 | 4,526 | 5,930 | 7,949 | 8,150 | 9,127 | 10,108 |
| Austrians | 2,240 | 2,980 | 3,363 | 3,536 | 3,474 | 1,894 | 427 | 125 |
| French | 614 | 615 | 617 | 716 | 892 | 783 | 663 | 694 |
| Spanish | 26,247 | 20,511 | 25,022 | 25,252 | 33,139 | 34,006 | 31,643 | 24,163 |
| Italians | 3,877 | 4,813 | 4,368 | 4,843 | 4,150 | 4,079 | 3,491 | 2,508 |
| Portuguese | 3,924 | 4,384 | 3,921 | 5,034 | 4,733 | 5,702 | 4,869 | 5,481 |
| Others | 11,762 | 12,434 | 11,442 | 16,196 | 21,533 | 25,322 | 30,019 | 34,811 |
| Unknown | 3,037 | 68 | 10 | 6 | ........ | 2 | ........ | ........ |
| Total | 198,225 | 198,024 | 199,584 | 218,541 | 252,681 | 253,141 | 232,340 | 255,922 |
| Per cent Americans | 47.3 | 48.4 | 47.4 | 43.5 | 43.2 | 42.9 | 41.9 | 47.6 |

[a] The summary for the year 1918 as printed in the report for 1918 at p. 27 contained several errors due to mistakes in transferring to the summary the correct details as stated on pp. 39–40. An erratum notice was sent out as soon as the error was seen.

Those classed as "others" in the columns above are mainly from the countries of South and Central America, some citizens of the new states created by the war, and a few Swiss shipping as stewards. The totals above, as stated, do not represent individual men, but frequently the same man has shipped on different voyages and on different ships. In ordinary years a fair average allowance is four such voyages and shipments, the years before the war thus covering about 60,000 men; but during the past year the proportion of long voyages has been greater and the number of new ships making thus only one or two voyages in the year has grown rapidly, so that from 85,000 to 90,000 individuals probably are covered by the statement.

## DESERTION OF SEAMEN.

The following return shows the number of men who have signed articles to ship and then failed to join. The percentage is the lowest in 10 years:

| Year. | Shipped and reshipped. | Failed to join. | Per cent. | Year. | Shipped and reshipped. | Failed to join. | Per cent. |
|---|---|---|---|---|---|---|---|
| 1909 | 181,032 | 2,114 | 1.17 | 1915 | 218,541 | 3,339 | 1.53 |
| 1910 | 185,721 | 2,690 | 1.45 | 1916 | 252,681 | 4,512 | 1.71 |
| 1911 | 192,191 | 3,062 | 1.60 | 1917 | 257,327 | 5,006 | 1.95 |
| 1912 | 198,225 | 3,849 | 1.94 | 1918 | 232,340 | 4,446 | 1.91 |
| 1913 | 198,024 | 3,906 | 1.97 | 1919 | 255,922 | 3,502 | 1.37 |
| 1914 | 199,584 | 2,771 | 1.39 | | | | |

under section 24 of the seamen's act of December 21, 1898, and since November 4, 1915, under the seamen's act, to seamen on vessels of the United States:

| Year. | Creditors. |  | Relatives. | Total. | Year. | Creditors. |  | Relatives. | Total. |
|---|---|---|---|---|---|---|---|---|---|
|  | Square-rigged. | All other vessels. |  |  |  | Square-rigged. | All other vessels. |  |  |
| 1906 | 1,492 | 421 | 309 | 2,222 | 1913 | 419 | 135 | 64 | 668 |
| 1907 | 1,323 | 490 | 239 | 2,052 | 1914 | 257 | 279 | 166 | 702 |
| 1908 | 967 | 393 | 133 | 1,493 | 1915 | 400 | 595 | 682 | 1,677 |
| 1909 | 660 | 114 | 84 | 858 | 1916 | 100 | 303 | 1,174 | 1,577 |
| 1910 | 631 | 145 | 79 | 905 | 1917 |  |  | 1,650 | 1,650 |
| 1911 | 505 | 241 | 57 | 803 | 1918 |  |  | 3,018 | 3,018 |
| 1912 | 555 | 296 | 62 | 913 | 1919 |  |  | 5,956 | 5,956 |

## WAGES OF SEAMEN.

The customary tables showing rates of wages are printed in Appendix B to preserve the continuity of the record. During the war, however, agreements on wages and conditions of work on shipboard were entered into and modified by those concerned and issued by the Shipping Board, which was the largest American owner of ships. These agreements, including the latest issued early in the current fiscal year, are included in the Appendix.

## NAVIGATION RECEIPTS.

The three main sources of Federal revenue from navigation have supplied the following receipts during the past five fiscal years, embracing the period of the war:

| Source. | 1915 | 1916 | 1917 | 1918 | 1919 |
|---|---|---|---|---|---|
| Tonnage duties | $1,315,425.30 | $1,454,565.83 | $1,393,743.16 | $1,171,418.36 | $1,265,229.23 |
| Navigation fees | 142,446.37 | 158,518.08 | 159,808.08 | 146,508.02 | 143,492.19 |
| Navigation fines | 41,518.24 | 52,381.75 | 49,962.37 | 32,097.68 | 162,146.50 |
| Yacht tax | 37,976.30 | 19,849.71 |  | 1,468.60 |  |
| Total | 1,537,366.21 | 1,685,315.37 | 1,603,513.56 | 1,351,492.66 | 1,570,867.92 |

The increase in receipts from tonnage duties is due mainly to the gradual resumption of commercial voyages after the armistice. American ships paid $258,105.11 in tonnage duties, but in so far as the payments were made by Shipping Board ships owned by the Government the receipts, of course, are essentially a matter of bookkeeping rather than of revenue. The large increase in fines is due to proceedings for forfeiture of the steamship *Sacramento* for fraudulent registry. This ship, a former German liner, by fraud secured an American register at San Francisco and then proceeded under German direction with supplies for the squadron of Admiral Von Spee off the island of Juan Fernandez. These supplies enabled the German squadron to sail to its destruction a short time later off the Falkland Islands. Proceedings for the forfeiture of the steamer were successful, and the forfeiture compromised for $250,000, of which one-half believed to be closed.

## RADIO COMMUNICATION.

During most of the past fiscal year the war conditions described in the report for 1918 have continued with practically no change. Under the Executive order of April 30, 1917, "to insure the proper conduct of the war against the Imperial German Government and the successful termination thereof" coast radio stations were operated by the Navy Department or closed, and the order is in force at this writing, pending ratification of the treaty of peace. The Navy Department continued the supervision of the allotment of radio apparatus to ship and shore stations, and it supplied naval radio operators to many ships.

The chief inspector, inspectors, and assistant inspectors who volunteered in April, 1917, continued with the American Expeditionary Forces in France or with the American Navy in European or home waters, and the worth of their technical services during the war has been recognized by promotions and by the award of decorations by the American and by the allied Governments. The former chief inspector (Lieut. Col. Louis R. Krumm) was in charge of the wireless operations of the American armies in France, an inspector (Maj. John L. Dillon) was in charge of the wireless operations of the artillery of the first Army in France, another inspector (Lieut. H. C. Gawler) was in charge of the wireless operations at the naval base in the Azores, and other members of the inspection force satisfactorily performed the less conspicuous military and naval duties in the line of their experience assigned to them with the armed forces.

The regular work of the inspection service was continued in the meantime by assistant inspectors promoted on the personal understanding voluntarily entered into that on the return of the inspectors serving with our armed forces in France and at sea they would yield their positions and return to their former status. The number of inspections of ship stations before clearance was 4,243, compared with 4,341 during the fiscal year 1918, with 6,103 during 1917 and 6,125 during 1916. Had the radio laws been in full operation, the number of inspections would have been much larger than in these earlier years. Many American ships were supplied with apparatus under distribution by the Navy and manned with naval radio operators, and for the time being the Navy was, in fact, responsible, in so far as any branch of Government is responsible, for the efficiency of such apparatus and operators. Even if the force of inspectors had been large enough and strong enough to carry out the inspection laws in full, of course, under the conditions that work would not have been undertaken. In the same way the wireless apparatus and operators on many foreign ships were temporarily supplied or controlled by their respective admiralty or navy departments, and, as a rule, were not closely inspected here as in ordinary times and under ordinary conditions. In addition to the foregoing, 954 inspections were made of apparatus on ships voluntarily equipped, compared with 1,434 during the year 1918.

The number of applicants examined for commercial operators' licenses was 2,426 during the past year, compared with 2,514 during 1918; but, in addition, 314 applicants were examined briefly for emergency permits permitting them to sail one voyage. The number of commercial operators licensed was 1,658 during the past year and 1,881 during the previous year. The service has been confronted throughout the war by the great need of skilled operators, in view of the heavy demands of the Army and Navy for qualified men. The question of a reduction of the standards of skill was decided adversely because the American radio operator's commercial license now ranks high abroad, as well as at home. To meet the need of operators, emergency permits were issued enabling an applicant who had fair but not standard attainments to take a ship on one voyage and perfect himself and on his return to try the examination again. In addition to their official work, several of the inspectors for much over a year up to the signing of the armistice in November devoted their time after office hours to teaching radiotelegraphy in classes or institutions established by local or private organizations to aid the winning of the war.

The number of ship stations licensed was only 250 during the past year and 196 during the previous year. This work is very much in arrears, as the number of American ship stations increased from 1,478 at the beginning of the fiscal year to 2,312 on June 30, 1919, and is now increasing at the average rate of nearly 100 a month.

### CURRENT CONDITIONS.

At the beginning of the current fiscal year nearly all the inspection force who had been serving with the Army in France or with the Navy in foreign or domestic waters were honorably discharged and had returned to their posts in the Service. During the war, radio communication on land and sea developed almost as rapidly as flying in the air, both in the extent of its uses and application and in invention and the mechanical improvement of apparatus and methods. In these developments and in the practical application of them under the trying conditions of warfare, the inspectors who resigned from the Radio Service of the Department of Commerce and volunteered in the Army or Navy within a week after our declaration of war have taken active and creditable parts, recognized by our own and allied Governments. They are specially qualified both by their former experience with the Bureau's Service, and by what they have done and learned during the war, to conduct the radio-inspection service upon which the volume of demands has been increased by great war appropriations for ships and the technical requirements extended by the inventions and improvements of the war. This is not the place and I am not the man to attempt more than the barest enumeration of some of these changes. Before the war transoceanic radio communication was experimental; now it is an everyday commercial affair across the Atlantic and the Pacific. Aviation before the war was virtually limited to inventors and men of considerable wealth and courage; it is now taking its place in commercial life, and wireless furnishes the means of communication between the flyer and those on land or sea. Very much of the communication between the armies on all fronts and their commanders was maintained by radio, and a great extension in wireless commercial communication on land is inevitable. Radiotelephony is a natural development of radiotelegraphy.

### COST OF RADIO SERVICE.

The total annual appropriation for the past five fiscal years and for the current year was $45,000, and the items of actual expenditure for those years are stated in the following table. During the period we were at war the volume of commercial wireless work of the Bureau was about the average of prewar years, while the great expansion was mainly under control of the armed forces and only recently is assuming a commercial status. The last column gives the details of the estimates for next year, submitted early in September in view of the increase and change in the nature of work now actually on hand and confronting the Service in the months just ahead.

The statement following shows details of expenditures for this service during the fiscal years 1915, 1916, 1917, 1918, 1919, the proposed distribution for the current fiscal year, and the estimates for 1921:

| | 1915 | 1916 | 1917 | 1918 | 1919 | 1920 | 1921 |
|---|---|---|---|---|---|---|---|
| **Total salaries:** | | | | | | | |
| Field | $27,844.49 | $28,379.51 | $27,784.66 | $24,068.17 | $28,602.88 | $31,880 | $93,638 |
| Bureau | 7,150.00 | 7,150.00 | 7,013.34 | 6,369.90 | 6,698.62 | 8,050 | 13,020 |
| Total | 34,994.49 | 35,529.51 | 34,798.00 | 30,438.07 | 35,301.50 | 39,930 | 106,658 |
| **General expenses:** | | | | | | | |
| Travel | 6,245.52 | 4,355.12 | 2,317.42 | 1,262.32 | 3,668.72 | 1,500 | 6,500 |
| Telephone | 399.84 | 401.81 | 565.88 | 617.03 | 695.89 | 700 | 1,200 |
| Laundry | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Furniture | 370.26 | 441.77 | 151.64 | 428.27 | 945.01 | 450 | 1,000 |
| Supplies | 517.49 | 331.90 | 558.76 | 495.19 | 234.22 | 485 | 1,000 |
| Printing | 78.10 | 116.60 | 68.79 | 17.46 | 135.40 | 15 | 200 |
| New instruments | 312.79 | 2,786.75 | 2,741.09 | 701.28 | 430.50 | 565 | 5,000 |
| Repairs | 1,455.65 | 109.78 | 83.05 | 180.22 | 348.61 | 200 | 500 |
| Telegrams | 111.51 | 33.47 | 24.33 | 34.91 | 27.16 | 25 | 100 |
| Freight and cartage | 124.84 | 89.34 | 63.23 | 60.59 | 78.81 | 65 | 200 |
| Carfare | 218.03 | 339.15 | 330.16 | 246.67 | 219.26 | 275 | 700 |
| Technical books and papers, batteries, wire, and other small materials | 168.38 | 57.00 | 47.30 | 95.80 | 74.05 | 100 | 404 |
| Berne publications | ........ | 198.91 | 13.74 | 8.73 | 37.78 | 15 | 100 |
| Rent | ........ | ........ | 98.75 | 149.25 | 638.00 | 675 | 2,100 |
| New construction and other equipment | ........ | ........ | ........ | 10,039.21 | 1,415.73 | ........ | 3,700 |
| Unexpended | 3.10 | 208.89 | 3,137.86 | 225.00 | 749.36 | ........ | ........ |
| Total | 45,000.00 | 45,000.00 | 45,000.00 | 45,000.00 | 45,000.00 | 45,000 | 129,262 |

### INCREASE IN RADIO COMMUNICATION.

In the meantime the number of American ships equipped with wireless has increased from 585 on June 30, 1915, to 2,312 on June 30, 1919, or fourfold, and is increasing at the rate of about 1,000 a year, owing to the appropriations by Congress to build ships. The number of ship stations licensed is very much in arrears and such ships are operating without compliance with law or international obligation, because the examinations necessary for the license could not be made in view of more pressing work in the inspection of ships for safety about to clear and in the examination of operators for commercial license. About August 1 the Navy Department withdrew lawfully manned. The inspection force, however, dropped most other work, and up to date 717 operators had been fully licensed and numerous temporary permits issued.

With the ratification of peace and the withdrawal of the Executive war order against radio communication, the commercial land stations will resume business presumably under commercial control, and the amateur transmitting stations and operators will be permitted to enter the restricted fields open to them under the statutes. The number of applications already filed with this Bureau in advance of the restoration of peace conditions points to the prospect of more general radio communication between points on land where wire communication is impracticable than before the war.

The following table shows briefly the growth of radio communication since 1915 and its present status, so far as these admit of concise statistical statement. The number of the inspection force, like the appropriation, was substantially unchanged on June 30. The substance of these statements has already been given to Congress.

| June 30— | American ships equipped. | American ships licensed. | Inspections of American and foreign ships. | Commercial operators licensed. | Commercial and experimental land stations. | Amateur stations licensed. | Amateur operators licensed. | Total inspection force. |
|---|---|---|---|---|---|---|---|---|
| 1915 | 585 | 362 | 6,152 | 1,653 | 115 | 3,547 | 3,067 | 26 |
| 1916 | 604 | 444 | 7,236 | 1,278 | 182 | 4,942 | 4,199 | 28 |
| 1917 | 836 | 484 | 7,137 | 1,682 | 160 | 3,741 | 3,302 | 28 |
| 1918 | 1,478 | 392 | 5,775 | 1,616 | ........ | ........ | ........ | 29 |
| 1919 | 2,312 | 976 | 5,160 | 1,645 | ........ | ........ | ........ | 27 |

The number and classification of the radio stations of the United States on June 30, 1919 (excluding 3,741 amateur transmitting stations which were closed in April, 1917, and have not yet been permitted to open, the Government stations being mainly those of the Army and Navy), and the grade and number of radio operators under license on June 30, 1919 (excluding amateurs, of whom 4,199 were licensed during the fiscal year 1916, and 3,302 during 1917 up to April, when the issue of such licenses ceased), were as follows:

| Radio stations. | | Radio operators. | |
|---|---|---|---|
| Classification. | Number. | Grade. | Number. |
| Commercial land radio stations | 47 | Commercial extra first | 48 |
| Commercial ship radio stations | 2,312 | Commercial first | 2,436 |
| Government land radio stations | 269 | Commercial second | 610 |
| Government ship radio stations | 1,580 | Emergency first | 13 |
| | | Emergency second | 3 |
| | | Cargo | 7 |
| Total | 4,208 | | 3,117 |

The officers in charge of the wireless operations of our armies in France commend highly the skill, ingenuity, and versatility of licensed amateur radio operators who volunteered in large numbers for military service and served in dangerous and responsible positions.

## SUMMARY OF WORK BY DISTRICTS FOR PAST YEAR.

Following is the usual statement by districts of the work performed during the past fiscal year:

| Place of inspection or examination. | Stations inspected. | | Operators examined. | | | | | Operators licensed. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Commercial. | | | Emergency. | Cargo. | Commercial. | | | Emergency. | | Cargo. |
| | Ship—Volunteer equipment. | Ship for license. | Extra first. | First. | Second. | | | Extra first. | First. | Second. | First. | Second. | |
| **First district:** | | | | | | | | | | | | | |
| Boston, Mass.— | | | | | | | | | | | | | |
| Total 1919 | 94 | 12 | 3 | 232 | 18 | ..... | 2 | 3 | 147 | 44 | ..... | ..... | 2 |
| Total 1918 | 127 | 12 | ..... | 200 | 25 | ..... | 22 | ..... | 145 | 12 | ..... | ..... | 18 |
| **Second district:** | | | | | | | | | | | | | |
| New York, N. Y.— | | | | | | | | | | | | | |
| Total 1919 | 141 | 50 | 5 | 619 | 60 | 97 | 11 | 4 | 432 | 54 | 14 | 2 | 10 |
| Total 1918 | 201 | 81 | 9 | 483 | 191 | ..... | 43 | 8 | 427 | 124 | ..... | ..... | 43 |
| **Third district:** | | | | | | | | | | | | | |
| Baltimore, Md | 82 | 35 | ..... | 174 | 13 | 52 | ..... | 4 | 143 | 19 | 16 | 5 | ..... |
| Norfolk and Newport News | 43 | 7 | ..... | 49 | 2 | 1 | ..... | ..... | 39 | 5 | 3 | ..... | ..... |
| Philadelphia | 19 | 7 | ..... | 78 | 5 | 37 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Total 1919 | 144 | 49 | ..... | 301 | 20 | 90 | ..... | 4 | 182 | 24 | 19 | 5 | ..... |
| Total 1918 | 439 | 10 | ..... | 121 | 10 | ..... | 8 | ..... | 119 | 18 | ..... | ..... | 7 |
| **Fourth district:** | | | | | | | | | | | | | |
| Savannah, Ga.— | | | | | | | | | | | | | |
| Total 1919 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Total 1918 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| **Fifth district:** | | | | | | | | | | | | | |
| New Orleans, La.— | | | | | | | | | | | | | |
| Total 1919 | 44 | 16 | 2 | 87 | 3 | 4 | 1 | 3 | 86 | 3 | 4 | 1 | 1 |
| Total 1918 | 41 | 10 | 1 | 102 | 6 | ..... | 15 | 1 | 62 | 26 | ..... | ..... | 11 |
| **Sixth district:** | | | | | | | | | | | | | |
| San Francisco, Calif.— | | | | | | | | | | | | | |
| Total 1919 | 91 | 33 | 2 | 259 | 26 | 8 | 7 | 3 | 177 | 33 | 8 | 2 | 15 |
| Total 1918 | 138 | 51 | 3 | 256 | 29 | ..... | 20 | ..... | 180 | 24 | ..... | ..... | 14 |
| **Seventh district:** | | | | | | | | | | | | | |
| Seattle, Wash.— | | | | | | | | | | | | | |
| Total 1919 | 83 | 26 | ..... | 220 | 55 | 15 | 5 | ..... | 155 | 29 | 5 | 1 | 5 |
| Total 1918 | 103 | 11 | ..... | 161 | 40 | ..... | 17 | ..... | 104 | 21 | ..... | ..... | 14 |
| **Eighth district:** | | | | | | | | | | | | | |
| Detroit, Mich | 212 | 41 | ..... | 179 | 14 | 44 | ..... | ..... | 59 | 48 | ..... | ..... | ..... |
| Ashtabula, Ohio | 5 | 3 | ..... | 1 | ..... | ..... | ..... | ..... | 1 | ..... | ..... | ..... | ..... |
| Buffalo, N. Y | ..... | ..... | ..... | 7 | 2 | 12 | ..... | ..... | 1 | 2 | ..... | ..... | ..... |
| Cleveland, Ohio | 25 | 7 | ..... | 10 | 1 | 12 | ..... | ..... | 6 | 3 | ..... | ..... | ..... |
| Frankford, Mich | 2 | 2 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Ludington, Mich | 3 | 1 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Total 1919 | 247 | 54 | ..... | 197 | 17 | 68 | ..... | ..... | 67 | 53 | ..... | ..... | ..... |
| Total 1918 | 169 | 15 | 2 | 275 | 154 | ..... | ..... | ..... | 113 | 107 | ..... | ..... | ..... |
| **Ninth district:** | | | | | | | | | | | | | |
| Chicago, Ill | 108 | 10 | 2 | 284 | 14 | 32 | ..... | 1 | 87 | 67 | 1 | 1 | ..... |
| Manitowoc, Wis | 2 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Total 1919 | 110 | 10 | 2 | 284 | 14 | 32 | ..... | 1 | 87 | 67 | 1 | 1 | ..... |
| Total 1918 | 197 | 3 | 1 | 354 | 75 | ..... | ..... | 1 | 173 | 119 | ..... | ..... | ..... |
| SUMMARY. | | | | | | | | | | | | | |
| First district | 94 | 12 | 3 | 232 | 18 | ..... | 2 | 3 | 147 | 44 | ..... | ..... | 2 |
| Second district | 141 | 50 | 5 | 619 | 60 | 98 | 11 | 4 | 432 | 54 | 14 | 2 | 10 |
| Third district | 144 | 49 | ..... | 301 | 20 | 90 | ..... | 4 | 182 | 24 | 19 | 5 | ..... |
| Fourth district | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Fifth district | 44 | 16 | 2 | 87 | 3 | 4 | 1 | 3 | 86 | 3 | 4 | 1 | 1 |
| Sixth district | 91 | 33 | 2 | 259 | 26 | 10 | 7 | 3 | 177 | 33 | 8 | 2 | 15 |
| Seventh district | 83 | 26 | ..... | 220 | 55 | 15 | 5 | ..... | 155 | 29 | 5 | 1 | 5 |
| Eighth district | 247 | 54 | ..... | 197 | 17 | 68 | ..... | ..... | 67 | 53 | ..... | ..... | ..... |
| Ninth district | 110 | 10 | 2 | 284 | 14 | 32 | ..... | 1 | 87 | 67 | 1 | 1 | ..... |
| Grand total 1919 | 954 | 250 | 14 | 2,199 | 213 | 317 | 26 | 18 | 1,333 | 307 | 51 | 12 | 33 |
| Grand total 1918 | 1,434 | 196 | 16 | 1,967 | 531 | ..... | 125 | 10 | 1,326 | 454 | ..... | ..... | 197 |

## ENFORCEMENT OF THE NAVIGATION LAWS.

The following table shows, by districts and laws violated, the result of the work of the Bureau in the enforcement of the navigation laws, the figures indicating the number of violations reported:

### VIOLATIONS OF THE NAVIGATION LAWS REPORTED BY THE VARIOUS COLLECTORS OF CUSTOMS, SHOWING THE LAWS VIOLATED FISCAL YEAR ENDED JUNE 30, 1919, COMPARED WITH PREVIOUS YEARS.

| Headquarters port. | Total. | Steamboat laws (R. S. 4399–4500). | Motor boat law, "Rules of road." | Surrendered license (R. S. 4325–4336). | Bills of health (Feb. 15, 1893). | Seamen's act (Mar. 4, 1915). | Anchorage and St. Marys River Rules. | Passenger act (Aug. 2, 1882). | Enrollment and license (R. S. 4336). | Entry and clearance (R. S. 4197, 2774). | Name on vessel (R. S. 4178). | Change of master (R. S. 4335). | Unlading. | Radio communication laws. | Numbering motor boats, act June 7, 1918. | Miscellaneous. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Baltimore | 500 | 32 | 134 | 30 | .... | .... | .... | .... | .... | .... | 22 | .... | .... | .... | 282 | .... |
| Boston | 243 | 59 | 31 | 67 | .... | .... | .... | 5 | 1 | 8 | 1 | .... | 9 | .... | 50 | 12 |
| Bridgeport | 95 | 1 | 62 | 27 | .... | .... | .... | .... | 1 | 1 | 2 | .... | 1 | .... | .... | .... |
| Buffalo | 168 | 63 | 42 | 1 | .... | 36 | .... | .... | 2 | 1 | 6 | .... | 9 | .... | 8 | .... |
| Charleston | 109 | 2 | 38 | 18 | .... | 1 | .... | .... | 1 | 2 | 17 | 1 | 1 | .... | 27 | 1 |
| Chicago | 88 | 31 | 16 | 2 | .... | 21 | .... | .... | .... | .... | .... | .... | .... | .... | 18 | .... |
| Cleveland | 499 | 340 | 111 | 14 | .... | 8 | .... | .... | .... | 10 | .... | 3 | 8 | .... | 3 | 2 |
| Des Moines | 27 | .... | 24 | 1 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 2 | .... |
| Detroit | 142 | 29 | 48 | 40 | .... | .... | .... | .... | 2 | 4 | 1 | 1 | 5 | 4 | 8 | .... |
| Duluth | 282 | 103 | 56 | 1 | .... | 119 | .... | .... | .... | .... | .... | .... | 2 | .... | 1 | .... |
| Galveston | 21 | 1 | 1 | 9 | .... | .... | .... | .... | .... | .... | 4 | .... | .... | .... | 6 | .... |
| Honolulu | 10 | 4 | .... | .... | .... | .... | .... | 4 | .... | .... | .... | .... | .... | .... | 14 | 2 |
| Indianapolis | 32 | .... | 17 | 1 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| Juneau | 43 | 2 | 4 | 29 | .... | .... | .... | .... | .... | 2 | .... | 1 | 5 | .... | .... | .... |
| Los Angeles | 192 | 1 | 85 | 29 | .... | .... | .... | .... | 1 | .... | 1 | .... | .... | .... | 75 | .... |
| Louisville | 49 | 3 | 12 | 12 | .... | .... | .... | .... | .... | .... | 3 | .... | .... | .... | 22 | .... |
| Memphis | 67 | 1 | 15 | 16 | .... | .... | .... | .... | .... | .... | .... | .... | 1 | .... | 31 | .... |
| Milwaukee | 81 | 6 | 72 | .... | .... | .... | .... | .... | .... | .... | 2 | .... | .... | .... | 1 | .... |
| Mobile | 98 | 2 | 6 | 34 | .... | 2 | .... | .... | .... | 2 | 5 | .... | .... | .... | 45 | 2 |
| New Orleans | 501 | 233 | 18 | 104 | .... | .... | .... | .... | 1 | 19 | 8 | 6 | 1 | 2 | 101 | 8 |
| New York | 626 | 163 | 230 | 123 | .... | .... | .... | 3 | .... | 3 | 1 | 1 | 2 | 50 | 50 | .... |
| Norfolk | 814 | 160 | 262 | 38 | .... | .... | .... | .... | 1 | 1 | 39 | 1 | 1 | 1 | 310 | .... |
| Ogdensburg | 54 | 1 | 21 | 25 | .... | .... | .... | .... | .... | .... | .... | .... | 7 | .... | .... | .... |
| Philadelphia | 532 | 17 | 261 | 81 | .... | 4 | .... | .... | 3 | 1 | 7 | 2 | 2 | .... | 154 | .... |
| Pittsburgh | 9 | 2 | .... | 4 | .... | .... | .... | .... | .... | 1 | .... | .... | 2 | .... | .... | .... |
| Port Arthur | 203 | 149 | 3 | 21 | .... | 6 | .... | 2 | 2 | 1 | 1 | 2 | 5 | .... | 4 | 7 |
| Portland, Me | 53 | 4 | 1 | 37 | .... | .... | .... | .... | 1 | .... | 2 | 1 | 5 | .... | 2 | .... |
| Portland, Oreg | 120 | 1 | 45 | 8 | .... | .... | .... | .... | 1 | .... | .... | 2 | .... | .... | 63 | .... |
| Providence | 65 | 4 | 24 | 6 | .... | .... | .... | 1 | .... | .... | .... | .... | 2 | .... | 28 | .... |
| Rochester | 14 | .... | 12 | 2 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| St. Albans | 1 | .... | .... | 1 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| St. Louis | 291 | 3 | 190 | 28 | .... | .... | .... | .... | 7 | .... | 2 | .... | 1 | .... | 67 | .... |
| San Antonio | 4 | .... | .... | 3 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 1 |
| St. Paul | 2 | .... | 2 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| San Francisco | 223 | 75 | 40 | 24 | .... | 5 | .... | 3 | .... | 15 | 4 | 2 | 2 | .... | 10 | 36 |
| San Juan | 8 | .... | 1 | 3 | .... | .... | .... | 1 | .... | .... | .... | .... | 1 | .... | 1 | 1 |
| Savannah | 77 | 22 | 25 | 8 | .... | .... | .... | .... | .... | .... | 1 | .... | 5 | .... | 19 | 2 |
| Seattle | 266 | 27 | 9 | 125 | .... | 50 | .... | 7 | 4 | 10 | 18 | 5 | 6 | 1 | 3 | 2 |
| Tampa | 1,303 | 47 | 344 | 86 | .... | 21 | .... | 2 | 8 | 2 | 32 | 1 | .... | .... | 744 | 10 |
| Wilmington, N. C | 261 | 1 | 135 | 8 | .... | .... | .... | .... | 2 | .... | 17 | 3 | .... | .... | 95 | .... |
| Total— | | | | | | | | | | | | | | | | |
| 1919 (40 ports) | 8,173 | 1,589 | 2,397 | 1,066 | .... | 273 | .... | 28 | 38 | 83 | 196 | 32 | 83 | 58 | 2,244 | 86 |
| 1918 (49 ports) | 4,749 | 710 | 2,337 | 922 | .... | 160 | .... | 32 | 20 | 62 | 127 | 27 | 250 | 20 | ...... | 82 |
| 1917 (48 ports) | 7,569 | 1,020 | 4,660 | 770 | .... | 286 | .... | 29 | 42 | 43 | 400 | 41 | 74 | 22 | ...... | 182 |
| 1916 (48 ports) | 7,825 | 812 | 5,126 | 943 | .... | 271 | 1 | 19 | 59 | 28 | 331 | 35 | 67 | 43 | ...... | 90 |
| 1915 (48 ports) | 6,868 | 671 | 4,462 | 982 | .... | .... | 11 | 10 | 104 | 41 | 348 | 67 | 93 | 37 | ...... | 42 |
| 1914 (49 ports) | 6,720 | 768 | 4,838 | 631 | .... | .... | 8 | 25 | 41 | 26 | 153 | 59 | 90 | 36 | ...... | 45 |
| 1913 (107 ports) | 3,506 | 333 | 2,783 | 23 | .... | .... | 23 | 8 | 24 | 10 | 83 | 26 | 1 | 40 | ...... | 152 |
| 1912 (105 ports) | 3,634 | 165 | 3,119 | 96 | 3 | .... | 12 | 17 | 38 | 39 | 81 | 12 | .... | .... | ...... | 52 |
| 1911 (92 ports) | 2,268 | 182 | 1,811 | 23 | 41 | .... | 17 | 45 | 10 | 16 | 43 | 30 | .... | .... | ...... | 50 |
| 1910 (74 ports) | 1,070 | 252 | 488 | 17 | 68 | .... | 13 | 61 | 13 | 16 | 68 | 12 | 2 | .... | ...... | 76 |
| 1909 (64 ports) | 1,134 | 151 | 710 | 33 | 69 | .... | 3 | 21 | 14 | 7 | 59 | .... | 4 | .... | ...... | 63 |
| 1908 (73 ports) | 852 | 245 | 385 | 12 | 42 | .... | 6 | 21 | 23 | 18 | 30 | 7 | 2 | .... | ...... | 61 |
| 1907 (66 ports) | 684 | 209 | 92 | 88 | 36 | .... | 18 | 62 | 9 | 23 | 52 | 27 | 5 | .... | ...... | 63 |
| 1906 (77 ports) | 670 | 194 | 110 | 114 | 41 | .... | 13 | 27 | 10 | 6 | 49 | 5 | 9 | .... | ...... | 72 |
| 1905 (63 ports) | 524 | 142 | 53 | 99 | 42 | .... | 13 | 21 | 26 | 7 | 20 | 11 | 28 | .... | ...... | 62 |
| 1904 (66 ports) | 706 | 134 | 93 | 101 | 48 | .... | 49 | 16 | 29 | 12 | 24 | 19 | (a) | .... | ...... | 131 |

[a] Included under "Miscellaneous" in 1904 report.

It will be noted that the number of violations of law reported is considerably in excess of that of any previous year, due principally to the enforcement of the numbering act of June 7, 1918. The increase in violations of the steamboat-inspection laws is due, to some extent, to the scarcity of licensed officers and able seamen, and the use, particularly between Gulf ports and Mexico, of freight vessels to carry passengers, all of which have been brought about by war conditions and the great increase in the merchant marine.

NUMBER OF VIOLATIONS OF THE NAVIGATION LAWS ON WHICH PENALTIES WERE IMPOSED AND SOURCES OF THE REPORTS FOR FISCAL YEAR 1919.

| Headquarters port. | Total. | Coast Guard. | Tarragon. | Kilkenny. | Local inspectors. | Radio. | Customs. | Navigation inspectors. |
|---|---|---|---|---|---|---|---|---|
| Baltimore | 484 | ........ | 397 | 7 | 26 | ........ | 28 | 26 |
| Boston | 238 | 6 | 2 | 2 | 59 | ........ | 158 | 11 |
| Bridgeport | 95 | ........ | 65 | ........ | ........ | ........ | 30 | ........ |
| Buffalo | 156 | 3 | ........ | ........ | 102 | ........ | 22 | 29 |
| Charleston | 102 | ........ | ........ | 78 | 1 | ........ | 23 | ........ |
| Chicago | 85 | 2 | ........ | ........ | 50 | ........ | 25 | 8 |
| Cleveland | 298 | 40 | ........ | ........ | 187 | ........ | 44 | 27 |
| Des Moines | 4 | ........ | ........ | ........ | ........ | ........ | 4 | ........ |
| Detroit | 122 | 26 | ........ | ........ | 31 | ........ | 65 | ........ |
| Duluth | 256 | ........ | ........ | ........ | ........ | ........ | 218 | 38 |
| Galveston | 21 | ........ | ........ | ........ | ........ | ........ | 21 | ........ |
| Honolulu | 8 | ........ | ........ | ........ | 2 | ........ | 6 | ........ |
| Indianapolis | 33 | 3 | ........ | ........ | ........ | ........ | 22 | 8 |
| Juneau | 41 | 1 | ........ | ........ | ........ | ........ | 40 | ........ |
| Los Angeles | 302 | ........ | ........ | ........ | ........ | ........ | 302 | ........ |
| Louisville | 45 | 3 | ........ | ........ | 2 | ........ | 33 | 7 |
| Memphis | 68 | ........ | ........ | ........ | 4 | ........ | 63 | 1 |
| Milwaukee | 84 | 81 | ........ | ........ | ........ | ........ | 3 | ........ |
| Mobile | 99 | ........ | 45 | ........ | 2 | ........ | 52 | ........ |
| New Orleans | 477 | ........ | 120 | ........ | 1 | ........ | 356 | ........ |
| New York | 606 | 2 | 117 | 76 | 64 | ........ | 285 | 62 |
| Nogales | 1 | ........ | ........ | ........ | ........ | ........ | 1 | ........ |
| Norfolk | 621 | ........ | 335 | 47 | 85 | 1 | 47 | 106 |
| Ogdensburg | 39 | ........ | ........ | ........ | ........ | ........ | 39 | ........ |
| Pembina | 1 | ........ | ........ | ........ | ........ | ........ | 1 | ........ |
| Philadelphia | 422 | ........ | 142 | 14 | 10 | 1 | 165 | 90 |
| Pittsburgh | 8 | 2 | ........ | ........ | ........ | ........ | 6 | ........ |
| Port Arthur | 142 | ........ | ........ | ........ | 8 | ........ | 134 | ........ |
| Portland, Me. | 41 | ........ | ........ | ........ | 3 | ........ | 38 | ........ |
| Portland, Oreg. | 119 | ........ | ........ | ........ | 1 | ........ | 55 | 63 |
| Providence | 59 | ........ | ........ | ........ | 4 | ........ | 8 | 47 |
| Rochester | 11 | ........ | ........ | ........ | ........ | ........ | 4 | 7 |
| St. Louis | 226 | ........ | ........ | ........ | 2 | ........ | 204 | 20 |
| St. Paul | 1 | ........ | ........ | ........ | ........ | ........ | 1 | ........ |
| San Antonio | 5 | ........ | ........ | ........ | ........ | ........ | 5 | ........ |
| San Francisco | 208 | 58 | ........ | ........ | 76 | ........ | 74 | ........ |
| San Juan | 8 | ........ | ........ | ........ | ........ | ........ | 8 | ........ |
| Savannah | 60 | ........ | ........ | 47 | 2 | ........ | 11 | ........ |
| Seattle | 255 | 8 | ........ | ........ | 16 | 4 | 223 | 4 |
| Tampa | 1,268 | ........ | 3 | 946 | 29 | ........ | 290 | ........ |
| Wilmington, N. C. | 263 | ........ | ........ | 263 | ........ | ........ | ........ | ........ |
| Total— | | | | | | | | |
| 1919 (41 ports) | 7,382 | 235 | 1,226 | 1,480 | 767 | 6 | 3,114 | 554 |
| 1918 (49 ports) | 4,893 | 241 | 809 | 84 | 404 | 5 | 2,654 | 696 |
| 1917 (48 ports) | 7,565 | 1,255 | 1,234 | 864 | 712 | 13 | 2,833 | 654 |
| 1916 (48 ports) | 7,895 | 1,333 | 987 | 984 | 590 | 36 | 2,876 | 1,089 |
| 1915 (48 ports) | 6,860 | 1,380 | 1,425 | ........ | 361 | 34 | 2,661 | 999 |
| 1914 (49 ports) | 6,720 | 922 | 1,762 | ........ | 734 | 27 | 3,275 | ........ |

The foregoing statement of the work done by the various inspection services engaged in the enforcement of the navigation laws is based on reports of collectors of customs and is approximately correct.

The material reduction of the work of the Coast Guard is, of course, due to the fact of its temporary transfer to the Navy Department and its employment in that service.

In addition to the facilities mentioned above for the enforcement of the law the Bureau expects this fall to receive from tne Navy Department the motor vessel *Dixie*, which was turned over to that Department for patrol duty during the war. There has been transferred to the Bureau also by the Navy Department two motor boats, the *Siwash* and *Psyche II*, which are particularly adapted to this work.

Under sections 500 and 1003 of the revenue act of 1918 taxes are imposed on motor boats not engaged exclusively in trade and also on transportation of freight and passengers for hire by such boats. The vessels employed by the Bureau are assisting the Bureau of Internal Revenue in the collection of these taxes. When Congress provides for the operation of the two new vessels turned over to us by the Navy Department we will be able to have a reasonably complete inspection service for the Atlantic and Gulf coasts, Mississippi River and tributaries, and one vessel on the Great Lakes.

### COMPARATIVE STATEMENT OF CASES OF VIOLATIONS OF THE NAVIGATION AND STEAMBOAT-INSPECTION LAWS REPORTED BY OFFICERS OF CUSTOMS, 1904–1919.

| Port. | 1904 | 1905 | 1906 | 1907 | 1908 | 1909 | 1910 | 1911 | 1912 | 1913 | 1914 | 1915 | 1916 | 1917 | 1918 | 1919 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Baltimore | 65 | 30 | 14 | 34 | 21 | 43 | 49 | 114 | 129 | 294 | 219 | 396 | 312 | 461 | 265 | 500 |
| Boston | 27 | 33 | 40 | 15 | 8 | 18 | 34 | 132 | 327 | 67 | 949 | 440 | 412 | 427 | 194 | 243 |
| Bridgeport | 8 | 7 | 12 | 9 | 9 | 4 | 13 | 206 | 423 | 30 | 134 | 118 | 54 | 89 | 32 | 95 |
| Buffalo | 1 | 3 | 3 | 5 | 10 | 8 | 32 | 9 | 75 | 64 | 3 | 42 | 144 | 87 | 111 | 168 |
| Charleston | 2 |  | 5 | 21 | 3 | 2 | 4 | 1 | 4 | 13 | 154 | 91 | 39 | 50 | 28 | 109 |
| Chicago | 8 | 7 | 8 | 7 | 21 | 5 | 70 | 138 | 55 | 35 | 105 | 178 | 389 | 283 | 144 | 88 |
| Cleveland | 14 | 14 | 20 | 20 | 27 | 10 | 32 | 114 | 66 | 76 | 90 | 104 | 218 | 161 | 177 | 499 |
| Des Moines | 1 |  | 2 | 3 | 5 | 4 |  |  | 3 |  | 160 | 85 | 4 | 116 | 56 | 27 |
| Detroit | 33 | 23 | 41 | 48 | 28 | 86 | 161 | 69 | 251 | 221 | 112 | 293 | 441 | 163 | 146 | 142 |
| Duluth | 34 | 16 | 15 | 16 | 15 | 14 | 46 | 9 | 13 | 15 | 17 | 62 | 79 | 138 | 132 | 282 |
| Eagle Pass |  |  |  |  |  |  |  | 1 | 3 | 28 | 2 |  |  | 1 | 1 |  |
| Galveston | 7 | 5 | 8 | 15 | 5 | 9 | 1 | 6 | 2 | 39 | 49 | 49 | 50 | 105 | 54 | 21 |
| Great Falls |  |  | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Honolulu | 6 | 2 | 8 |  | 7 | 17 | 20 | 14 | 14 | 11 | 15 | 14 | 18 | 18 | 11 | 10 |
| Indianapolis |  |  |  |  | 2 |  |  | 7 | 23 | 5 | 1 | 5 | 109 | 54 | 85 | 32 |
| Juneau | 18 | 21 | 10 | 22 | 9 | 8 | 17 | 113 | 67 | 27 | 41 | 43 | 33 | 40 | 44 | 43 |
| Laredo | 1 |  |  |  |  |  |  | 1 | 16 | 5 | 14 | 2 | 7 | 10 |  |  |
| Los Angeles |  | 8 | 5 | 5 | 52 | 4 | 26 | 65 | 36 | 23 | 79 | 182 | 172 | 137 | 109 | 192 |
| Louisville |  | 1 | 2 | 5 |  |  | 1 | 14 | 24 | 6 | 41 | 58 | 63 | 128 | 50 | 49 |
| Memphis | 3 | 3 | 7 | 4 | 4 | 3 | 8 | 10 | 12 | 9 | 10 | 52 | 94 | 84 | 18 | 67 |
| Milwaukee | 2 | 6 | 9 | 4 | 14 | 19 | 13 | 16 | 22 | 16 | 16 | 8 | 133 | 82 | 18 | 81 |
| Mobile | 21 | 35 | 32 | 23 | 6 | 9 | 41 | 36 | 40 | 30 | 157 | 107 | 106 | 109 | 52 | 98 |
| New Orleans | 11 | 15 | 38 | 21 | 21 | 16 | 24 | 51 | 71 | 73 | 218 | 173 | 177 | 315 | 221 | 501 |
| New York | 164 | 132 | 160 | 124 | 250 | 638 | 174 | 292 | 352 | 330 | 1,013 | 622 | 1,256 | 1,292 | 583 | 626 |
| Nogales |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 22 |  |
| Norfolk | 43 | 13 | 21 | 16 | 170 | 66 | 43 | 214 | 121 | 489 | 235 | 335 | 531 | 430 | 181 | 814 |
| Ogdensburg | 5 | 4 | 2 | 4 | 4 | 6 | 6 | 13 | 25 | 20 | 57 | 40 | 92 | 74 | 201 | 54 |
| Pembina |  |  |  |  |  |  |  |  |  | 8 |  |  |  |  | 3 |  |
| Philadelphia | 25 | 12 | 26 | 16 | 10 | 8 | 17 | 25 | 28 | 164 | 378 | 867 | 483 | 406 | 166 | 532 |
| Pittsburgh |  |  |  |  | 3 | 5 |  | 1 | 24 | 6 | 21 | 13 | 27 | 4 | 6 | 9 |
| Port Arthur |  |  |  | 6 | 4 | 3 | 5 | 28 | 35 | 10 | 126 | 33 | 68 | 93 | 117 | 203 |
| Portland, Me | 7 | 9 | 5 | 7 | 14 | 13 | 26 | 86 | 157 | 51 | 78 | 566 | 241 | 145 | 51 | 53 |
| Portland, Oreg | 7 | 7 | 11 | 5 | 2 | 3 | 6 | 7 | 125 | 331 | 354 | 278 | 229 | 130 | 239 | 120 |
| Providence | 1 | 2 | 14 | 9 | 9 | 13 | 7 | 79 | 70 | 20 | 130 | 21 | 125 | 94 | 68 | 65 |
| Rochester |  |  | 4 | 1 | 2 | 1 | 7 | 18 | 23 | 42 | 34 | 28 | 42 | 44 | 102 | 14 |
| St. Albans |  |  |  |  |  | 2 |  |  | 4 | 1 | 54 | 3 | 33 | 68 | 29 | 1 |
| St. Louis |  |  | 1 |  | 3 | 3 | 8 | 30 | 88 | 20 | 109 | 186 | 154 | 348 | 173 | 291 |
| St. Paul | 1 | 1 | 1 |  |  | 2 |  | 3 |  |  | 5 | 1 | 5 |  |  | 4 |
| San Antonio [a] |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 2 | 2 |
| San Francisco | 6 | 20 | 11 | 73 | 25 | 20 | 70 | 103 | 64 | 107 | 260 | 446 | 276 | 196 | 151 | 223 |
| San Juan | 11 | 4 | 4 | 3 | 13 | 3 | 9 | 9 | 25 | 18 | 28 | 28 | 11 | 12 | 14 | 8 |
| Savannah | 5 | 1 | 7 | 1 | 6 | 2 | 1 | 2 | 7 | 6 | 98 | 78 | 82 | 48 | 41 | 77 |
| Seattle | 138 | 54 | 72 | 87 | 33 | 29 | 19 | 74 | 108 | 59 | 38 | 306 | 409 | 318 | 338 | 266 |
| Tampa | 27 | 33 | 46 | 54 | 29 | 27 | 80 | 135 | 682 | 364 | 669 | 314 | 570 | 547 | 295 | 1,303 |
| Wilmington, N.C. | 4 | 3 | 5 | 1 | 8 | 11 | 5 | 23 | 20 | 373 | 104 | 206 | 137 | 262 | 19 | 261 |
| Total (45 ports). | 706 | 524 | 670 | 684 | 852 | 1,134 | 1,070 | 2,268 | 3,634 | 3,506 | 6,720 | 6,868 | 7,826 | 7,569 | 4,749 | 8,173 |

[a] The districts of Laredo (No. 23) and Eagle Pass (No. 25) were abolished by Executive order Sept. 7, 1917, and the district of San Antonio (No. 23) was created by the same order.

## PREVENTION OF OVERCROWDING OF PASSENGER VESSELS.

Owing to the cessation of hostilities and the withdrawal of Government restrictions, there was a material increase in the excursion business on water. From the following table it will be noted that the total number of passengers counted as going on vessels during the year at the principal ports aggregated 7,873,791. This does not include the excursion business out of the port of New York, conditions being such that that office made no report during the year.

### NUMBER OF COUNTS AND THE NUMBER OF PASSENGERS INVOLVED IN PREVENTING OVERCROWDING OF PASSENGER VESSELS DURING FISCAL YEAR 1919.

| Port. | Navigation. | | Customs. | | Total. | |
|---|---|---|---|---|---|---|
| | Counts. | Passengers. | Counts. | Passengers. | Counts. | Passengers. |
| Baltimore | 1,333 | 673,253 | 1 | 349 | 1,334 | 673,602 |
| Boston | | | 439 | 402,931 | 439 | 402,931 |
| Bridgeport | | | 1 | 722 | 1 | 722 |
| Buffalo | | | 2,051 | 522,021 | 2,051 | 522,021 |
| Charleston, | | | 2 | 829 | 2 | 829 |
| Chicago | 1,702 | 309,770 | 118 | 41,922 | 1,820 | 358,892 |
| Cleveland | 2,494 | 427,034 | 125 | 121,829 | 2,619 | 548,863 |
| Detroit | 751 | 4,589,675 | 194 | 281,429 | 945 | 4,871,104 |
| Duluth | 78 | 18,396 | 45 | 16,146 | 123 | 34,542 |
| Galveston | | | 29 | 758 | 29 | 758 |
| Indianapolis | | | 17 | 8,692 | 17 | 8,692 |
| Louisville | 129 | 44,607 | 1 | 773 | 130 | 45,380 |
| Memphis | 56 | 24,741 | | | 56 | 24,741 |
| Mobile | | | 56 | 17,908 | 56 | 17,908 |
| New York | | | 1 | 31 | 1 | 31 |
| Norfolk | 104 | 21,411 | 151 | 61,886 | 255 | 83,297 |
| Philadelphia | | | 99 | 120,153 | 99 | 120,153 |
| Port Arthur | | | 67 | 165 | 67 | 165 |
| Portland, Me | 647 | 96,371 | | | 647 | 96,371 |
| Portland, Oreg | | | 9 | 1,249 | 9 | 1,249 |
| Providence, | 86 | 45,690 | | | 86 | 45,690 |
| Rochester | | | 34 | 15,132 | 34 | 15,132 |
| Savannah | | | 1 | 270 | 1 | 270 |
| St. Albans | | | 250 | 448 | 250 | 448 |
| Total | 7,380 | 6,250,948 | 3,691 | 1,622,843 | 11,071 | 7,873,791 |
| Total for 1918 | 8,447 | 2,931,570 | 5,129 | 1,985,202 | 13,576 | 4,916,772 |

The following table shows, by ports, the occasions on which vessels reached their passenger capacity and were prevented by our inspectors from taking on more passengers. On 408 occasions 186,307 passengers were prevented from going on the boats. While it does not follow that on each of these occasions there would have been a dangerous overcrowding of the vessels, it is safe to assume that on a number of such occasions life would have been endangered had it not been for the protection of this service.

SHUT-OFFS, BY MONTHS, DURING THE FISCAL YEAR 1919.

| Port. | July. | | August. | | September. | | December. | | May. | | June. | | Total. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Counts. | Passengers. | Counts. | Passengers. | Counts. | Passengers. | Counts | Passengers. | Counts. | Passengers. | Counts. | Passengers. | Counts. | Passengers. |
| Baltimore | 3 | 3,600 | 2 | 1,700 | 4 | 5,080 | 2 | 600 | 2 | 3,100 | 5 | 3,550 | 18 | 17,630 |
| Boston | 1 | 1,970 | 3 | 1,095 | 3 | 1,095 | | | | | | | 7 | 4,160 |
| Buffalo | 4 | 4,950 | 3 | 1,650 | 2 | 1,150 | | | | | | | 9 | 7,750 |
| Chicago | 121 | 25,112 | 83 | 6,328 | 17 | 2,984 | | | 6 | 1,212 | 81 | 15,854 | 308 | 51,490 |
| Cleveland | | | 2 | 5,000 | | | | | 3 | 7,000 | 3 | 220 | 8 | 12,220 |
| Detroit | 5 | 9,916 | 3 | 4,762 | | | | | 8 | 23,557 | 10 | 24,743 | 26 | 62,978 |
| Duluth | | | 3 | 2,808 | | | | | | | | | 3 | 2,808 |
| Memphis | 1 | 750 | | | | | | | | | 1 | 750 | 2 | 1,500 |
| Mobile | | | 1 | 550 | | | | | | | 1 | 568 | 2 | 1,118 |
| Norfolk | | | | | | | | | 1 | 1,000 | | | 1 | 1,000 |
| Philadelphia | 6 | 9,600 | 5 | 8,200 | | | | | | | | | 11 | 17,800 |
| Portland, Me | | | | | 1 | 300 | | | | | | | 1 | 300 |
| Portland, Oreg | 2 | 200 | | | | | | | | | | | 2 | 200 |
| Providence | 1 | 235 | 2 | 2,000 | | | | | | | | | 3 | 2,235 |
| Rochester | 5 | 2,238 | | | 2 | 880 | | | | | | | 7 | 3,118 |
| Total | 149 | 58,571 | 107 | 34,093 | 29 | 11,489 | 2 | 600 | 20 | 35,869 | 101 | 45,685 | 408 | 186,307 |
| Total for 1918 | 188 | 112,664 | 83 | 99,937 | 14 | 16,816 | | | 15 | 6,390 | 85 | 32,213 | 385 | 268,020 |

## NUMBERING UNDOCUMENTED VESSELS.

The act of June 7, 1918, regarding the numbering of undocumented vessels, went into effect on December 7, 1918, and since that time up to July 1 of this year 91,916 such vessels have been numbered throughout the country. The numbering of these boats is done without cost, and in the manner in which automobiles are numbered and for similar purposes. The identification of the owners of these small vessels assists materially in the enforcement of the navigation laws and the collection of taxes. In addition to this, the local authorities at the various ports have found it of material assistance in the enforcement of the harbor-police laws and regulations. The law has met with approval among motor-boat owners, and most effective service has been rendered the Government in the enforcement of the law by the motor-boat publications of the country.

## INSPECTION VESSELS.

During the past season there has been a general resumption of the use of motor boats for pleasure purposes, increasing the necessity for the use of the inspection boats in safeguarding the lives of those using them.

At the beginning of the war the Bureau turned over to the Navy the motor boat *Dixie* which was adapted to naval patrol work and she was in constant service in Hampton Roads. This vessel is now being overhauled and repaired, and will be turned back in the near future.

The Navy Department, also, has turned over to the Bureau two small motor boats, the *Siwash* and *Psyche II*, which are especially adapted to this work. It is expected that these vessels will be placed in service about January 1.

It is proposed to station the *Siwash* with headquarters at New York to cover the New England coast. The *Kilkenny* will cover Chesapeake and Delaware bays and North Carolina sounds. The *Tarragon*, a small vessel of light draft, will be stationed at Jacksonville to cover

*Psyche II* will be employed on the Great Lakes.

The inspection vessels are small, ranging from 60 to 93 feet in length and carry crews ranging from 5 to 7. They are economical in operation and with its five vessels, which we now have, the Bureau should be able to make a reasonable inspection of the Atlantic and Gulf coasts, Mississippi River and tributaries, and a portion of the Great Lakes. The revenue derived from their work in the collection of taxes and navigation fines should exceed the cost of their operation. They will be of material assistance in extending to the millions of people using this means of navigation the protection of the navigation laws.

## PASSENGER ACT OF 1882.

During the past fiscal year passenger ships on 314 voyages brought 55,603 steerage passengers to the United States, compared with 442 voyages carrying 67,988 passengers in the fiscal year 1918; 630 voyages carrying 147,493 passengers in 1917; 720 voyages carrying 154,057 passengers in 1916; and 956 voyages carrying 211,057 passengers in 1915.

## RECOGNITION OF HEROISM.

Even before our declaration of war in April, 1917, American officers and men on our merchant ships were placed in peril by submarine attacks, and in numerous instances those whose ships had been sunk eagerly shipped on other ships. Such conduct is entitled to official recognition, and a committee has been appointed to make recommendations on this subject. Official recognition in all its forms, to have any value, should be proportionate and discriminating, so it is best to wait until the final general form of recognizing the valor of men in the Army and Navy has been decided before reaching a conclusion about men in the merchant marine. In the British merchant marine thus far a "torpedo badge" has been awarded to officers and men who were serving on merchant ships which were torpedoed, and who joined other ships afterwards. Where men have undergone the danger a second time a second badge has been awarded, and in case of death the badge is awarded to the widow or oldest orphan.

Respectfully,

Eugene Tyler Chamberlain,
*Commissioner.*

To Hon. William C. Redfield,
*Secretary of Commerce.*

(A) Reports of shipping commissioners for year ended June 30, 1919—(1) Shipments, discharges, and expenditures; (2) Shipments and reshipments of seamen; (3) Number of men discharged; (4) Nationality of seamen; (5) Failures of seamen to join American vessels; (6) Men shipped to be discharged in foreign ports; (7) Allotments of wages; (8) Seamen shipped and discharged by collectors.

(B) Wages of seamen—(1) Average monthly wages paid in the American merchant marine, year ended June 30, 1919; (2) Average monthly wages paid to able seamen on American vessels, 1895–1919; (3) Average monthly wages paid to first mates on American vessels, 1895–1919; (4) Average monthly wages paid to firemen and first engineers on American steam vessels, 1895–1919; (5) Wage scales established by the U. S. Shipping Board.

(D) Tonnage tax—Law and collections—(1) Tonnage-tax collections, 1884–1919; (2) Tonnage tax collected, year ended June 30, 1919, by customs districts; (3) Tonnage tax collected, year ended June 30, 1919, by nationality of vessels; (4) Tonnage tax collected, year ended June 30, 1919, by countries from which the vessels entered.

(E) Steel-ship building in the United States—(1) Construction of steel steam vessels in the United States, 1910–1919; (2) Steel merchant vessels building, or under contract to be built, for private shipowners, July 1, 1919.

(F) The world's tonnage, motive power, and materials of construction—(1) World's tonnage, based on official returns, 1850–1911 (from Return on Progress of British Shipping for 1912); (2) Number and net and gross tonnage of steam and sailing vessels as recorded by the Bureau Veritas for 1918–19; (3) Number, gross tonnage, and description of steam and sailing vessels of over 100 tons, of the several countries of the world, as recorded in Lloyd's Register for 1919–20; (3*a*) Number and net and gross tonnage of steam vessels of over 100 tons, of the several countries of the world, as recorded in Lloyd's Register for 1914–15; (3*b*) Number, tonnage, and description of the sailing vessels of 100 tons net, of the several countries of the world, as recorded in Lloyd's Register for 1914–15; (4) Motive power and chief materials of construction of the world's merchant marine, 1890–1919 (Lloyd's); (5) Total number and tonnage of steam vessels (over 100 tons) and sailing vessels (over 50 tons), 1890–1918 (Bureau Veritas); (6) Construction—Vessels built in the world (over 100 tons) according to Lloyd's (including vessels not recorded in Lloyd's), 1890–1913; (7) Mercantile shipbuilding in 1918, excluding warships (Lloyd's Register); (8) Merchant vessels under construction June 30, 1919 (Lloyd's); (9) Number, tonnage, and nationality of vessels totally lost, condemned, etc., during the year 1914, as reported up to July 12, 1915; also the number and tonnage of steam and sailing vessels owned in each country.

(G) Progress of British, German, and Japanese shipping.

(H) Square-rigged American vessels—Number and gross tonnage, by rig and material of which built, June 30, 1919.

(I) Foreign-built vessels admitted to American registry during the year ended June 30, 1919, classified in chronological order of issue of registry.

(J) War losses—(1) American documented vessels destroyed by mines, submarines, etc., during the war; (2) Undocumented American vessels destroyed.

(K) Miscellaneous—(1) Foreign carrying trade of the United States, 1821–1919; (2) Tonnage of American and foreign vessels entered and cleared in the foreign trade of the United States, fiscal years 1821–1919; (3) Water-borne imports and domestic exports of United States, by nationality of vessels, fiscal years 1915–1919; (4) Water-borne imports and exports of United States, by months, fiscal years 1915–1919; (5) Activity of British shipping; (6) American merchant vessels sold to aliens and reported during the year ended June 30, 1919; (7) Vessels of 500 gross tons and over adapted for merchant service transferred to the Navy or the War Department since April 6, 1917.

### STATISTICAL TABLES.

(1) Number and gross tonnage of documented vessels of the United States, by customs districts, June 30, 1919.

(2) Number and gross tonnage of documented vessels of the United States, by States and Territories, June 30, 1919.

(3) Number and gross tonnage of documented steam and gas vessels of the United States, by customs districts, June 30, 1919.

(4) Number and gross tonnage of documented metal vessels of the United States, by customs districts, June 30, 1919.

(5) Number and gross tonnage of documented steam and gas metal vessels of the United States, by customs districts, June 30, 1919.

(6) Class, number, and gross tonnage of documented metal vessels of the United States, by customs districts, June 30, 1919.

(7) Number and gross tonnage of each class of documented wooden and metal vessels of the United States, June 30, 1919.

(8) Balance sheet of tonnage accounts, showing the increase and decrease of documented vessels, June 30, 1919.

(9) Balance sheet of tonnage accounts, showing the increase and decrease in each class of vessels, June 30, 1919.

(10) Documented sailing and steam tonnage constituting the total merchant marine of the United States, 1789–1919.

(10*a*) Number and gross tonnage of canal boats and barges documented in the United States, in specified years, 1868–1919.

(10*b*) Number and gross tonnage of sailing vessels, steam vessels, canal boats, and barges documented on the northern lakes, in specified years, 1868–1919.

(11) Number and gross tonnage of sailing vessels, steam vessels, gas vessels, canal boats, and barges in the United States, by customs districts, June 30, 1919.

(12) Number and gross tonnage of sailing vessels, steam vessels, gas vessels, canal boats, and barges in the United States, by States, June 30, 1919.

(13) Sailing, steam, and gas vessels of the United States, according to size, June 30, 1919.

(14) Number and gross tonnage of vessels of the United States engaged in the cod and mackerel fisheries, by customs districts, June 30, 1919.

(15) Number and gross tonnage of vessels of the United States engaged in the whale fisheries, by ports, June 30, 1919.

(16) Documented tonnage of the United States merchant marine employed in the foreign trade, the coasting trade, and the fisheries, 1789–1919.

(17) Employment of the tonnage of the United States, June 30, 1919.

(18) Class, number, and gross tonnage of vessels built in the United States and documented during the year ended June 30, 1919, by customs districts.

(19) Class, number, and gross tonnage of sailing vessels built in the United States and documented during the year ended June 30, 1919.

(20) Class, number, and gross tonnage of steam and gas vessels built in the United States and documented during the year ended June 30, 1919.

(21) Class, number, and gross tonnage of steel vessels built in the United States and documented during the year ended June 30, 1919.

and documented, 1797–1919.

(24) Number and gross tonnage of vessels built in the United States and documented, 1857–1919, by geographic divisions.

(25) Tonnage of vessels of the United States which have been built, admitted to registry by acts of Congress, etc., and those which have been lost, abandoned, sold to aliens, etc., 1813–1919.

(26) Class, number, and gross tonnage of documented yachts of the United States, by ports, June 30, 1919.

(27) Class, number, and gross tonnage of documented metal yachts of the United States, by ports, June 30, 1919.

(28) Class, number, and gross tonnage of yachts built in the United States and documented during the year ended June 30, 1919, by customs districts.

(29) Class, number, and gross tonnage of documented yachts lost, abandoned, sold to aliens, etc., year ended June 30, 1919.

# REPORT

### OF THE

# CHIEF OF THE APPOINTMENT DIVISION

### OF THE

# CHIEF OF APPOINTMENT DIVISION.

Department of Commerce,
Appointment Division,
*Washington, September 2, 1919.*

Sir: There is submitted herewith my annual report as Chief of the Appointment Division for the fiscal year ended June 30, 1919.

## STATISTICS RELATING TO THE PERSONNEL.

The accompanying table shows, by bureaus, the number of permanent positions in the Department on July 1, 1919, and the increase or decrease in each bureau as compared with July 1, 1918. The figures do not include temporary appointments, nor do they include the following appointments or employments not made by the head of the Department: Persons engaged in rodding, chaining, recording, heliotroping, etc., in field parties of the Coast and Geodetic Survey; temporary employments in field operations of the Bureau of Fisheries; mechanics, skilled tradesmen, and laborers, employed in field construction work in the Lighthouse Service. Enlisted men on vessels of the Coast Survey in the Philippine Islands and officers and men of the Navy Department employed on vessels of the Bureau of Fisheries are also excluded. The total of these excluded miscellaneous employments and enlistments is approximately 5,000, as compared with 4,444 for the fiscal year 1918. At the close of the fiscal year 1919 there were 1,262 employees in the service of the Department serving under temporary appointment or employment.

The total number of permanent positions referred to in the accompanying table, together with the employments and enlistments just mentioned, on July 1, 1919, was approximately 12,349 as compared with 11,051 on July 1, 1918.

| Bureau. | Statutory. | Nonstatutory. | Total. | In District of Columbia. | Outside District of Columbia. | Increase (+) or decrease (−). |
|---|---|---|---|---|---|---|
| Office of the Secretary | 183 | .......... | 183 | 183 | .......... | 5 |
| Bureau of the Census | 636 | 712 | 1,348 | [a] 695 | 653 | −49 |
| Bureau of Foreign and Domestic Commerce | 152 | 153 | 305 | [a] 174 | 131 | 85 |
| Bureau of Standards | 381 | 615 | 996 | 902 | 94 | −65 |
| Bureau of Fisheries | 424 | 4 | 428 | 82 | 346 | 8 |
| Bureau of Lighthouses | 56 | 5,762 | [b] 5,818 | 43 | 5,775 | − 5 |
| Coast and Geodetic Survey | 336 | 606 | 942 | [a] 369 | 573 | [c] 402 |
| Bureau of Navigation | [d] 45 | 159 | 204 | 45 | 159 | −29 |
| Steamboat-Inspection Service | 311 | 97 | 408 | 14 | 394 | 61 |
| Total | 2,524 | 8,108 | 10,632 | 2,507 | 8,125 | 413 |

[a] Employees engaged in work in the field for a part of each year, with headquarters in Washington, are treated as within the District of Columbia.

[b] Includes the following positions, appointment to which is not made by the head of the Department: 415 mechanics, skilled tradesmen, and laborers employed in field construction work in the Lighthouse Service and work of a similar character at the general lighthouse depot at Tompkinsville, N. Y.; 1,513 laborers in charge of post lights; and 1,343 members of crews of vessels.

[c] Includes employees on vessels retransferred from the jurisdiction of the Navy Department. Comparable statistics in last year's report showed a loss of 250 for this bureau.

[d] Includes 2 stenographers and typewriters authorized by law for not exceeding 6 months during the year.

tions of a permanent nature shown in the preceding table, is given in the table below:

| | Office of the Secretary. | Bureau of the Census. | Bureau of Foreign and Domestic Commerce. | Bureau of Standards. | Bureau of Fisheries. | Bureau of Lighthouses. | Coast and Geodetic Survey. | Bureau of Navigation. | Steamboat Inspection Service. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|
| **Classified service:** | | | | | | | | | | |
| Competitive— | | | | | | | | | | |
| Statutory— | | | | | | | | | | |
| In District of Columbia | 140 | 622 | 146 | 357 | 72 | 35 | 190 | 28 | 12 | 1,602 |
| Outside District of Columbia | ...... | ...... | ...... | ...... | 310 | 17 | ...... | 15 | 286 | 628 |
| Nonstatutory— | | | | | | | | | | |
| In District of Columbia | ...... | 25 | 18 | 498 | 1 | 4 | 24 | 15 | ...... | 585 |
| Outside District of Columbia | ...... | ...... | 25 | 92 | 3 | 2,631 | 98 | 95 | 96 | 3,040 |
| Total | 140 | 647 | 189 | 947 | 386 | 2,687 | 312 | 153 | 394 | 5,855 |
| Excepted— | | | | | | | | | | |
| Statutory— | | | | | | | | | | |
| In District of Columbia— | | | | | | | | | | |
| Presidential | ...... | ...... | ...... | ...... | ...... | 4 | ...... | ...... | ...... | 4 |
| Other | 5 | ...... | 2 | ...... | 1 | ...... | 1 | 1 | 1 | 11 |
| Outside District of Columbia | ...... | ...... | ...... | ...... | 22 | ...... | ...... | ...... | ...... | 22 |
| Nonstatutory— | | | | | | | | | | |
| In District of of Columbia | ...... | 12 | 4 | 3 | ...... | ...... | ...... | ...... | ...... | 19 |
| Outside District of Columbia | ...... | ...... | 106 | 1 | ...... | 271 | 19 | 45 | 1 | 443 |
| Total | 5 | 12 | 112 | 4 | 23 | 275 | 20 | 46 | 2 | 499 |
| **Unclassified service:** | | | | | | | | | | |
| Statutory— | | | | | | | | | | |
| In District of Columbia— | | | | | | | | | | |
| Presidential | 2 | 2 | 3 | 1 | 2 | ...... | 141 | 1 | 1 | 153 |
| Other | 36 | ...... | 1 | 23 | 6 | ...... | 4 | ...... | ...... | 70 |
| Outside District of Columbia— | | | | | | | | | | |
| Presidential | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 11 | 11 |
| Other | ...... | ...... | ...... | ...... | 11 | ...... | ...... | ...... | ...... | 11 |
| Nonstatutory— | | | | | | | | | | |
| In District of Columbia | ...... | 34 | ...... | 20 | ...... | ...... | 9 | ...... | ...... | 63 |
| Outside District of Columbia | ...... | 653 | ...... | 1 | ...... | 2,856 | 456 | 4 | ...... | 3,970 |
| Total | 38 | 689 | 4 | 45 | 19 | 2,856 | 610 | 5 | 12 | 4,278 |
| Grand total | 183 | 1,348 | 305 | 996 | 428 | 5,818 | 942 | 204 | 408 | 10,632 |

## CHANGES IN THE PERSONNEL.

The following table gives a summary of changes in the personnel of the Department for the fiscal year ended June 30, 1919:

| Bureau. | Permanent. | | | | Temporary. | Grand total. | Promotions. | Reductions. |
|---|---|---|---|---|---|---|---|---|
| | Competitive. | Excepted. | Unclassified. | Total. | | | | |
| Office of the Secretary | 90 | 2 | 12 | 104 | 186 | 290 | 76 | ....... |
| Bureau of the Census | 178 | .......... | 488 | 666 | 473 | 1,139 | 410 | 1 |
| Bureau of Foreign and Domestic Commerce | 88 | 79 | .......... | 167 | 148 | 315 | 159 | 1 |
| Bureau of Standards | 554 | 14 | 27 | 595 | 1,314 | 1,909 | 774 | 23 |
| Bureau of Fisheries | 94 | 6 | 14 | 114 | 118 | 232 | 46 | 3 |
| Bureau of Lighthouses | 441 | 15 | .......... | 456 | 482 | 938 | 2,239 | [b]79 |
| Coast and Geodetic Survey | 60 | 10 | 6 | 76 | 227 | 303 | 98 | 14 |
| Bureau of Navigation | 44 | 19 | 7 | 70 | 67 | 187 | 45 | ....... |
| Steamboat-Inspection Service | 159 | .......... | .......... | 159 | 80 | 239 | 300 | 1 |
| Total | 1,708 | 145 | 554 | 2,407 | 3,095 | [c]5,502 | 4,147 | 122 |

| Bureau. | Separations.[d] | | | | | | Miscellaneous changes.[e] |
|---|---|---|---|---|---|---|---|
| | From permanent positions. | | | | From temporary positions. | Grand total. | |
| | Competitive. | Excepted. | Unclassified. | Total. | | | |
| Office of the Secretary | 82 | 3 | 2 | 87 | 112 | 199 | 51 |
| Bureau of the Census | 125 | .......... | 870 | 995 | 34 | 1,029 | 45 |
| Bureau of Foreign and Domestic Commerce | 70 | 19 | .......... | 89 | 58 | 147 | 30 |
| Bureau of Standards | 372 | 1 | 5 | 378 | 1,127 | 1,505 | 89 |
| Bureau of Fisheries | 59 | .......... | 2 | 61 | 57 | 118 | 5 |
| Bureau of Lighthouses | 413 | 4 | .......... | 417 | 238 | 655 | 78 |
| Coast and Geodetic Survey | 55 | 3 | .......... | 58 | 89 | 147 | 58 |
| Bureau of Navigation | 41 | 2 | 2 | 45 | 36 | 81 | 23 |
| Steamboat-Inspection Service | 41 | .......... | .......... | 41 | 13 | 54 | 17 |
| Total | 1,258 | 32 | 881 | 2,171 | 1,764 | 3.935 | 396 |

[a] Includes appointments of the following character: Presidential, by selection from civil-service certificates, under Executive order, to excepted positions, by reinstatement, and by reason of transfer within the Department or from other departments or independent establishments.

[b] Mainly voluntary reductions accepted by employees to secure more desirable conditions of living.

[c] Includes a large number of appointments by reason of increase of compensation.

[d] Includes separations by reason of resignations, discontinuances, removals, deaths, transfers within the Department, and transfers from the Department to other departments or independent establishments.

[e] Includes reappointments by reason of change of station, name, designation, extensions of temporary appointments, changes from temporary to permanent status, etc.

The foregoing table indicates a condition of unrest among the employees of the Department, which may be considered reflective of that which exists in other circles of activity. Dissatisfaction with conditions, an ever prevailing and abnormal desire to change with a view to improving those conditions, a shortage in some classes of eligibles rendering temporary appointments necessary, and a deterioration of qualifications offered by many appointees, cooperate to make the personnel turnover unduly large and consequently to augment the work of the Division. The appointments and separations reported by the Division five years ago were 1,609 and 1,389, respectively. During the past fiscal year the pressure of work resulting from this increase has necessitated abnormal strain on the clerks of the Division and involved considerable overtime work.

## PROMOTIONS.

In spite of the unusual number of losses among employees during the last fiscal year and of the difficulty of securing qualified apoutside its service. This policy is well established and is appreciated by the employees, who thereby have an incentive to prepare themselves for more responsible duties, thus acquiring a more general knowledge of the Department's activities and increasing their value to it. It also has a tendency to minimize the desire to seek better paid opportunities elsewhere, which desire has become abnormally evident and is the cause of much derangement of governmental work. As a result of the war conditions, the number of opportunities for promotion has been unusually large and promotions, therefore, have been frequent.

Among certain classes of the Department's employees where outside competition was keen, the Department, in order to maintain efficient service, has been compelled from time to time to give promotions in the way of increased salaries. In no other manner was it possible to retain a sufficient and efficient force among such classes as mechanics, crews and officers of vessels, etc.

## LEAVES OF ABSENCE.

The following table shows, by bureaus, the total and average amount of annual and sick leave, stated separately and together, taken by the employees of the Department in the District of Columbia, arranged according to sex, during the calendar year 1918. It also shows the average leave, by bureaus, as compared with 1917. The averages for 1918 show a decrease of 2.30 days of annual leave, and an increase of 2.04 days sick leave over the average of 1917, this increase being undoubtedly due to the epidemic of Spanish influenza that was prevalent during the latter part of 1918. The total average of annual and sick leave for 1918 is 33.05 days against 33.30 for the year 1917, or a decrease of 0.25 day.

TOTAL AND AVERAGE AMOUNT OF ANNUAL AND SICK LEAVE, BY BUREAUS, STATED SEPARATELY AND TOGETHER, TAKEN BY THE EMPLOYEES OF THE DEPARTMENT IN THE DISTRICT OF COLUMBIA, ARRANGED ACCORDING TO SEX, DURING THE CALENDAR YEAR 1918, AND AVERAGE LEAVE FOR 1917.

MALE.

| Bureau. | Number.[a] | Annual leave.[b] | | Sick leave. | | Total. | | Average, 1917. |
|---|---|---|---|---|---|---|---|---|
| | | Days. | Average. | Days. | Average. | Days. | Average. | |
| Office of the Secretary | 67 | 1,711 | 25.54 | 514 | 7.67 | 2,225 | 33.21 | 28.55 |
| Bureau of the Census | 283 | 8,030 | 28.37 | 2,284 | 8.07 | 10,314 | 36.45 | 34.83 |
| Bureau of Foreign and Domestic Commerce | 74 | 1,979 | 26.74 | 785 | 10.61 | 2,764 | 37.35 | 35.17 |
| Bureau of Standards | 398 | 5,880 | 14.77 | 2,096 | 5.27 | 7,976 | 20.04 | 24.59 |
| Bureau of Fisheries | 41 | 1,047 | 25.54 | 247 | 6.02 | 1,294 | 31.56 | 30.72 |
| Bureau of Lighthouses | 21 | 597 | 28.43 | 221 | 10.52 | 818 | 38.95 | 33.78 |
| Coast and Geodetic Survey | 128 | 3,578 | 27.95 | 1,230 | 9.61 | 4,808 | 37.56 | 32.24 |
| Bureau of Navigation | 16 | 386 | 24.13 | 64 | 4.00 | 450 | 28.13 | 32.17 |
| Steamboat-Inspection Service | 5 | 132 | 26.40 | 50 | 10.00 | 182 | 36.40 | 29.00 |
| Total and average | 1,033 | 23,340 | 22.59 | 7,491 | 7.25 | 30,831 | 29.85 | 30.70 |

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[a] Only those employees were included who are considered as being entitled to the full yearly allowance of both annual and sick leave.

[b] In the count of the annual leave all periods of one-half day and over were counted as a full day, periods of less than one-half day were omitted.

### TOTAL AND AVERAGE AMOUNT OF ANNUAL AND SICK LEAVE, ETC.—Continued.

#### FEMALE.

| Bureau. | Number. | Annual leave. |  | Sick leave. |  | Total. |  | Average, 1917. |
|---|---|---|---|---|---|---|---|---|
|  |  | Days. | Average. | Days. | Average. | Days. | Average. |  |
| Office of the Secretary | 43 | 1,186 | 27.58 | 472 | 10.98 | 1,658 | 38.56 | 35.29 |
| Bureau of the Census | 245 | 7,345 | 29.98 | 3,217 | 13.13 | 10,562 | 43.11 | 41.85 |
| Bureau of Foreign and Domestic Commerce | 26 | 744 | 28.62 | 429 | 16.50 | 1,173 | 45.12 | 37.62 |
| Bureau of Standards | 26 | 482 | 18.54 | 200 | 7.69 | 682 | 26.23 | 59.00 |
| Bureau of Fisheries | 22 | 640 | 20.09 | 253 | 11.50 | 893 | 40.59 | 41.57 |
| Bureau of Lighthouses | 4 | 118 | 29.50 | 68 | 17.00 | 186 | 46.50 | 53.50 |
| Coast and Geodetic Survey | 20 | 573 | 28.65 | 256 | 12.80 | 829 | 41.45 | 42.29 |
| Bureau of Navigation | 7 | 210 | 30.00 | 82 | 11.71 | 292 | 41.71 | 42.83 |
| Steamboat-Inspection Service | 4 | 120 | 30.00 | 36 | 9.00 | 156 | 39.00 | ........ |
| Total and average | 397 | 11,418 | 28.76 | 5,013 | 12.63 | 16,431 | 41.39 | 41.08 |

#### TOTAL.

| Bureau. | Number. | Annual leave. |  | Sick leave. |  | Total. |  | Average, 1917. |
|---|---|---|---|---|---|---|---|---|
|  |  | Days. | Average. | Days. | Average. | Days. | Average. |  |
| Office of the Secretary | 110 | 2,897 | 26.34 | 986 | 8.96 | 3,883 | 35.30 | 30.81 |
| Bureau of the Census | 528 | 15,375 | 29.12 | 5,501 | 10.42 | 20,876 | 39.54 | 37.97 |
| Bureau of Foreign and Domestic Commerce | 100 | 2,723 | 27.23 | 1,214 | 12.14 | 3,937 | 39.37 | 35.50 |
| Bureau of Standards | 424 | 6,362 | 15.00 | 2,296 | 5.41 | 8,658 | 20.42 | 24.85 |
| Bureau of Fisheries | 63 | 1,677 | 26.77 | 500 | 7.94 | 2,187 | 34.71 | 33.67 |
| Bureau of Lighthouses | 25 | 715 | 28.60 | 289 | 11.56 | 1,004 | 40.16 | 35.50 |
| Coast and Geodetic Survey | 148 | 4,151 | 28.05 | 1,486 | 10.04 | 5,637 | 38.09 | 33.17 |
| Bureau of Navigation | 23 | 596 | 25.91 | 146 | 6.35 | 742 | 32.26 | 33.56 |
| Steamboat-Inspection Service | 9 | 252 | 28.00 | 86 | 9.56 | 338 | 37.56 | 29.00 |
| Total and average | 1,430 | 34,758 | 24.30 | 12,504 | 8.74 | 47,262 | 33.05 | 33.30 |

The following statement, based on the percentages of the preceding table, shows the relative standing of the bureaus for the calendar years 1918 and 1917 with respect to the lowest average amount of leave used. The Bureau of Standards has the lowest average per employee of both annual and sick leave:

### RELATIVE POSITIONS OF BUREAUS FOR 1918 AND 1917 WITH REGARD TO THE USE OF THE LEAVE PRIVILEGES.

| Bureau. | Annual leave. |  | Sick leave. |  | Total. |  |
|---|---|---|---|---|---|---|
|  | 1918 | 1917 | 1918 | 1917 | 1918 | 1917 |
| Office of the Secretary | 3 | 2 | 4 | 3 | 4 | 3 |
| Bureau of Foreign and Domestic Commerce | 5 | 6 | 9 | 7 | 8 | 8 |
| Bureau of the Census | 9 | 9 | 7 | 9 | 7 | 9 |
| Bureau of Standards | 1 | 1 | 1 | 2 | 1 | 1 |
| Bureau of Fisheries | 4 | 3 | 3 | 8 | 3 | 6 |
| Bureau of Lighthouses | 8 | 8 | 8 | 6 | 9 | 7 |
| Coast and Geodetic Survey | 7 | 4 | 6 | 5 | 6 | 4 |
| Bureau of Navigation | 2 | 5 | 2 | 4 | 2 | 5 |
| Steamboat-Inspection Service | 6 | 7 | 5 | 1 | 5 | 2 |

Another statement prepared in this Division shows that only 47 per cent of the total number of employees considered (1,430) took all of their annual leave, as compared with 58 per cent in 1917; that 7 per cent took all of their sick leave, against 4 per cent in 1917; that 27 per cent took no sick leave, against 33 per cent in 1917; and that 5 per cent took all their annual and sick leave, against 3½ per cent in 1917. Eleven employees were reported as taking no annual or sick leave during the year.

In February last, following the practice of the Department, an examination was made of the leave record of all employees for the past three years. The examination showed that only 10 employees (a decrease of 3 employees for 1915, 1916, and 1917) in two bureaus took substantially all of their annual and sick leave during the calendar years 1916, 1917, and 1918.

The names of these employees were brought to the attention of the bureau chiefs concerned. After considering each case thoroughly, steps were taken which, it is believed, will have a tendency to reduce the excessive amount of leave taken wherever it was considered there might be a disposition to abuse the sick-leave privilege.

### OFFICIAL BONDS.

The following table shows the character, number, and penalty of bonds of officers of the Department required by law or regulation, and the number of each kind given during the fiscal year ended June 30, 1919:

| Bonded as— | Total number bonded. | Number bonded during fiscal year. | Aggregate penalty. | Statute or regulation requiring bond. |
|---|---|---|---|---|
| Disbursing clerk, Department of Commerce.[a] | 1 | 1 | $50,000 | Sec. 176, R. S. |
| Special disbursing agent | 96 | 58 | 739,500 | Sec. 3614, R. S. |
| Chief of party, Coast and Geodetic Survey. | [b] 94 | 46 | 388,000 | Sundry civil appropriation act, approved July 1, 1918, and prior years. |
| Shipping commissioner, Bureau of Navigation. | 14 | 3 | 70,000 | Sec. 4502, R. S., as amended by the act of Apr. 26, 1906. |
| Hydrographic and geodetic engineer in charge of office, Coast and Geodetic Survey. | 1 | ........ | 2,000 | Par. 370, Regulations and Instructions for the Government of the Coast and Geodetic Survey, effective Jan. 1, 1913. |
| Total | 206 | [c] 108 | 1,249,500 | |

[a] The bond of the disbursing clerk of the Department is subject to the approval of the Secretary of the Treasury, and all records pertaining thereto are maintained by the Treasury Department.

[b] The number of bonded officers of the Coast and Geodetic Survey was increased during the fiscal year through the retransfer of 33 of its former employees from the service and jurisdiction of the War and Navy Departments.

[c] Includes 12 bonds given for the purpose of renewal or change in penalty.

### COMPILATION OF DATA RELATING TO THE PERSONNEL.

The records maintained by the Division enable it to promptly comply with requests for information respecting the personnel. An idea of the varied character of the data furnished may be gathered from the following brief description of some of the statements prepared during the fiscal year:

Statement showing salaries of mechanical and subclerical employees in the District of Columbia.

Employees located in the District of Columbia appointed from Iowa.

Statement showing total number of male officers and employees; the number between the ages of 21 and 31; and the number who received deferred classification.

Number of employees who left the service to enter the Army or Navy.

List of employees appointed from Louisiana.

Number of employees performing duty in the District of Columbia.

Number of statutory and nonstatutory employees whose scale of pay is less than $1,080 per annum.

Statement showing number and salaries of clerks in statutory and nonstatutory grades in the District of Columbia.

Estimated increase in compensation under proposed legislation fixing a minimum salary of $1,080 per annum.

Detailed statement relating to annual and sick leave taken in 1918 by employees in the District of Columbia, compared with 1917.

Weekly reports of appointments and separations for the use of the Division of Housing and Health, War Department, in connection with its work of providing accommodations for appointees.

Original report (to accompany questionnaires) for the congressional Joint Commission on Reclassification of Salaries, and subsequent bimonthly reports of changes.

Data compiled from questionnaires executed by the employees of the Department, relative to the establishment of night classes for Government employees.

Estimated number of appointments and separations in the District of Columbia during a period of seven months.

### DECISIONS OF THE COMPTROLLER OF THE TREASURY.

The following decisions relating to the personnel of the Department were rendered by the Comptroller of the Treasury during the fiscal year:

*July 24, 1918.*—That employees of the Bureau of Standards paid from a lump-sum appropriation provided for under act of March 20, 1918, are entitled to the $120 increase of compensation authorized by act of July 3, 1918, as the Bureau of Standards was created by law prior to January 1, 1916.

*July 31, 1918.*—Navigation inspectors serving under permanent appointment are not considered as employees whose duties require only a portion of their time, or whose services are utilized for brief intervals, and are entitled to the $120 increase of compensation authorized by act of July 3, 1918.

*August 5, 1918.*—Per diem laborers and mechanics in the Lighthouse Service, when required to work on Saturday afternoons between June 15 and September 15 (Saturday half-holiday period), are not entitled to extra pay for such service.

*August 9, 1918.*—Officers and enlisted men of the Army detailed for duty at the Bureau of Standards can not be paid traveling expenses in connection with their duties at the Bureau from appropriations for the Bureau of Standards, such expenses being payable from appropriations for the Army.

*August 21, 1918.*—When a certificate is furnished by the head of a department establishing the ability and qualifications of an employee to justify the $120 increase, further certification is unnecessary in case of future promotions in excess of $200 per annum, during the fiscal year 1919.

*September 14, 1918.*—That the $120 increase under act of July 3, 1918, applies to the Government service generally and not to service in any particular department or establishment. Employees transferred to this Department from another department or independent establishment will not have to be certified for the increase of compensation provided the employee would have been entitled to the increase by reason of his service in the former department or establishment.

*November 20, 1918.*—The 5 and 10 per cent and the $120 per annum additional compensation authorized by Congress is not to be considered as annual pay for the purpose of computing retired rate of pay of employees of the Lighthouse Service.

*March 26, 1919.*—Trade commissioners and their assistants serving in foreign countries and paid from an allotment from the national security and defense fund can not be paid for personal services from said fund after June 30, 1919, but their transportation and necessary traveling expenses in returning to their homes in this country may be paid after July 1, 1919, provided such expenses are provided for by their appointments.

*April 29, 1919.*—Inspectors in the Steamboat-Inspection Service may be allowed the $240 per annum increase of compensation authorized by section 7 of the act of March 1, 1919.

## SALARIES.

The legislative, executive, and judicial appropriation act approved March 1, 1919, provides $240 per annum increase of compensation for the fiscal year 1920, in lieu of the $120 bonus allowed during the past fiscal year, in recognition of the necessity under present living conditions for upward revision of salaries. This, however, but partially meets the necessities of conditions and the temporary increase of compensation is not at all comparable with the increase in cost of living. The compensation of keepers of lighthouses in the Lighthouse Service was, in addition, increased on November 1, 1918, from an average pay of $600 to approximately $840 per annum under authority of the act of June 20, 1918, which, among other things, amended section 4673 of the Revised Statutes by increasing the authorized maximum average salary of this class of employees.

It has been necessary, as far as appropriations would admit, to make various additional increases in salaries and allowances of employees paid from lump sums. Officers and crews of vessels, laborers, mechanics, and others in trades positions, and technical, and clerical employees in commercial life receive much higher compensation than formerly, necessitating increases in the pay of Government employees in similar grades in order to retain old employees or to secure eligibles for filling vacancies. Individual increases, when made as a matter of expediency, create inequalities, however, especially as compared with the pay of employees in Washington and elsewhere occupying positions the salaries of which are fixed by law.

The Nolan minimum compensation bill now before Congress is an attempt to minimize the hardship involved in the combination of low salary and high cost of living in cases where it bears most heavily. It is, however, but a partial solution of the problem. It is hoped that systematic and adequate relief in this respect will be accomplished through the work of the congressional Joint Commission on Reclassification of Salaries established under the act of March 1, 1919.

The present $900 entrance salary for clerks should be abolished. Even with the bonus it is not sufficient to secure experienced clerks, notably stenographers and typewriters, who can readily obtain from $1,200 to $1,500 per annum elsewhere, and there is a chronic dearth of this class of eligibles on the registers of the Civil Service Commission. The entrance compensation for clerks should be at least $1,200 per annum, which is not more than is paid in many places for common labor.

During the year the subsistence allowance of officers and crews of vessels operated by the Lighthouse Service, Bureau of Fisheries, and Coast and Geodetic Survey were further increased in amounts ranging from 20 to 50 per cent over former allowances by reason of increased cost of foodstuffs.

## CIVIL-SERVICE METHODS.

It was anticipated that the changed conditions incident to the cessation of hostilities and the release of clerks and other employees engaged exclusively on war work would have the effect of relieving the difficulty experienced by the Department in filling vacancies, but such has not been the result, due, however, to the low entrance salaries

Executive order was issued on November 29, 1918, under which the names of persons in the competitive classified service with unrestricted status who had been appointed prior to the date of the order and who had served less than three years, could be restored to appropriate eligible registers upon their separation because of a reduction of force, eligibility thereon to continue for one year from the date of separation. This was extended by Executive order of April 30, 1919, to cover employees who had been appointed after November 29, 1918. Although there have been reductions of force in some branches of the Government service, other establishments have increased their forces to such an extent that the Civil Service Commission has stated that the demand for eligibles of many kinds is such that all are being certified as fast as names are entered on the reemployment register.

The force of the Department was increased by more than 400 new employees during the past fiscal year, and through lack of eligibles for immediate appointment it was necessary to make a large number of temporary appointments from outside the registers under the general authority granted by the Civil Service Commission for making such appointments, provided that informal inquiry made at the time showed that there were no eligibles on the registers available for temporary service. It has been the commission's practice, however, to require such temporary appointees to make application for examination.

During the exigency created by the war the Civil Service Commission on occasion authorized permanent appointment in individual cases to various positions under the Executive order of March 26, 1917, or under section 10 of civil-service Rule II, without competitive examination, but the commission advised the Department on March 11, 1919, that in view of changed conditions due to the closing of the war it is no longer considered necessary to make noncompetitive appointments thereunder, and that in the future it will make effort to provide eligibles for any vacancy that might occur and which could not be filled previously through the regular civil-service channels.

The Executive order of April 2, 1917, requiring the assent of the head of a department or office to an employee's examination or certification under the civil-service rules has been rescinded.

Under the terms of an Executive order dated June 30, 1919, the Civil Service Commission may enter upon its register for stenographer, typewriter, or stenographer and typewriter, at Washington, D. C., or elsewhere, the name of a person certified and appointed within three years from any of these registers who is found to be assigned principally in point of time or importance to work not requiring proficiency in the technical subjects upon which he was examined.

The reinstatement rule was amended by Executive order dated April 16, 1918, so as to harmonize and consolidate provisions relating to war veterans, their widows, and Army nurses. The new provisions are substantially as follows:

1. An honorably discharged veteran of the Civil War or the War with Spain, his widow, or an Army nurse of either war, separated from the competitive classified service before the date of the order, may be reinstated in the same

**competitive classified service may be reinstated in any part of the competitive classified service within five years from the date of honorable discharge from the military service if he has the required fitness to perform the duties of the position to which his reinstatement is sought.**

**3. The widow of a veteran of the war with Germany formerly in the competitive classified service, who was the wife of such veteran while he was in the military service, may be reinstated in any part of the competitive classified service within five years from the date of termination of her husband's military service by death or honorable discharge.**

Reinstatements under the above rule, as amended, are granted only upon the approval of the Civil Service Commission, subject to other requirements of the civil-service rules, such as members of family in the service, etc. In the case, however, of a person enlisted or drafted in the war with Germany who is honorably discharged from the military service and who desires to be restored to his former position in the civil service, the act of February 25, 1919 (40 Stat., 1164), provides that he shall be reinstated if he is qualified to perform the duties of the position, and therefore the provisions of the civil-service rules do not apply, nor is the approval of the Civil Service Commission necessary to the reinstatement. A report is made to the commission by the Department of the facts in each case when such reinstatement is made.

The civil-service status of two classes of positions were affected by Executive orders issued during the year upon recommendation of the Department. The new position of Assistant to the Secretary was excepted from examination under the civil-service rules, and all laborers at light stations or in charge of minor lights whose duties require but a portion of their time were excepted from examination, whenever, in the opinion of the lighthouse superintendent, it is not considered in the interests of the service to make selections from registers of eligibles. Formerly only those receiving a compensation of $300 or less were so exempt.

The Department has actively cooperated with the Civil Service Commission in taking steps to inform new employees before coming to Washington of housing conditions and the facilities provided for their aid in securing accommodations.

During the fiscal year the Department made 780 requests upon the Civil Service Commission for certificates of eligibles for filling vacancies in various positions.

Taking into consideration the abnormal conditions involving simultaneously a shortage of and an unusually large demand for eligibles, the civil-service machine has functioned satisfactorily, and there has been shown by the officials of the Department and of the commission a desire to cooperate that has helped to dissipate some and minimize other of the difficulties that had to be encountered.

## SUPERANNUATION AND RETIREMENT.

While "Hope deferred maketh the heart sick," the superannuated Government employee should remember that "When night is darkest dawn is nearest." The old and faithful public servant is still striving to hold on to his position at the cost, perhaps, of some of his few remaining years of life, looking hopefully for the dawn of a new era when he will be enabled to retire with a small pension which, with the help of the little he may have been able and fortunate enough to lay aside from his meager salary, will provide sufficient for his declining years. The increased interest and demand for such action is manifested by the number of bills, with this object in view, which have been introduced in Congress. One, the Lehlbach bill, has passed the House of Representatives and has been introduced in the Senate. It will be a great boon to the superannuated employee and an inspiration to the active one, not only in its distant outlook but in the immediate future, removing obstacles to well-earned promotions; moreover, it will permit the replacing of the worn-out clerk by a young, active worker; thus in the end the cost will be a profitable investment both to the employee and to the Government.

There has been put in operation during the past fiscal year a retirement system for a certain class of the Department's employees—keepers and other field employees of the Lighthouse Service. Since its initiation, October 31, 1918, 111 employees have been retired with an average pension of $529.11. This system in two important features differs from the bill previously referred to, in that it is noncontributory and that the pension is a certain proportion of the average pay for the last five years' service without restriction as to the maximum amount. The pensions granted vary from less than $100 to $1,800 per annum. There is no question as to the beneficial effects of this innovation on the personnel; in fact, but for it, the service would have been much more seriously crippled than it has been by the low salaries that could be offered, in many cases quite inadequate to provide an acceptable living for the employee and his family.

It is hoped that we have reached the time when the question of a retirement pension for superannuated Government employees will pass from the academic to the practical stage. If years of devoted service with insufficient compensation is deserving of reward, the superannuated Government employee is entitled to the boon of a retirement pension in his old age.

## EFFECT OF THE WAR SITUATION ON THE PERSONNEL AND PERSONNEL WORK.

The personnel of the Division and its work have been seriously affected by the conditions due to the war. It was necessary to make 10 appointments to the force during the year to fill vacancies occurring in its personnel, consisting of 11 employees. A labor turnover of 90 per cent in any organization must have a more or less demoralizing effect, and especially is it true with respect to such a small organization. The situation was relieved, however, by the fact that, with two exceptions, the changes took place in the lower-grade positions. The volume of work for the year, based upon the number of changes in the personnel, was the greatest in the history of the Division, being 55 per cent greater than for 1918, and 185 per cent greater than for 1916, a prewar year. Every detail of the work has been closely scrutinized, with the view to eliminating such steps as did not appear to be absolutely necessary under war conditions. Under authority of a suggestion made by you, short cuts which did not perceptibly lower efficiency have been adopted, unnecessary steps have been omitted, and informal methods substituted for the formal, accomplishing a saving both in labor and time. Notwithstanding such efforts, the Division's force has been taxed to the utmost to keep the work current. Much overtime work has been necessary, and in some cases the annual leave has been curtailed. With the exception of the detail of five employees from other branches of the Department for various short periods, the Division's force has been the same as under peace conditions, when the work was much lighter.

With respect to the effect of the war upon the personnel of the Department as a whole, it is believed that the conditions existing in this Division have prevailed to a greater or less extent throughout the Department. A comparison of the number of employees, exclusive of certain enlistments and temporary employments, and the number of separations and appointments for the past fiscal year with those for the preceding three fiscal years, as set forth in the following table, clearly shows the handicap under which the personnel labored as a result of the abnormally large number of changes taking place:

| | 1916 | 1917 | 1918 | 1919 |
|---|---|---|---|---|
| Total personnel | 9,903 | 10,079 | 11,051 | 11,894 |
| Separations | 1,809 | 1,551 | 2,585 | 3,935 |
| Percentage of separations | 18 | 15 | 23 | 33 |
| Appointments | 1,326 | 2,146 | 3,930 | 5,502 |
| Percentage of appointments | 13 | 21 | 36 | 50 |

While the personnel for 1919 is only 20 per cent larger than that for the lowest of the three preceding years, the number of appointments and separations are 301 per cent of the lowest of the three preceding years. The situation was further aggravated by the lack of properly qualified eligibles for permanently filling the vacancies as they occurred, which condition made it necessary to make temporary appointments in a large majority of cases. The extent to which this was carried is shown by the fact that for the fiscal year 1919 there were 3,095 temporary appointments, compared with 2,106 for 1918, 944 for 1917, and 502 for 1916, showing an increase of 516 per cent in 1919 over 1916, the lowest of the three preceding years and the last year before the war. Temporary appointments in permanent positions are undesirable from the standpoint of efficiency, and the more so when the force is in a crippled condition as was the case during the past year.

It was feared that the reinstatement of former employees who left to take a more active part in the war would necessitate the dropping of employees who had been filling the places in the interim. But it has been found that the necessary rearrangements could be made without friction and without involving hardship; in fact it rarely has been necessary to drop the hold-over employee.

One feature resulting from the war is perceptible among the Department's employees, as elsewhere, namely, the increase in number of females. Throughout the various offices, positions formerly filled by men have been well and adequately filled by women, the majority of whom do not evidence any desire or intention to relinquish the vocation which they were forced by circumstances or chose to adopt during the continuance of the war. For the past two or three years it has been almost impossible to secure male eligibles for the lower clerical grades, with the result that women have availed themselves of the opportunity thus presented for entrance into the Government service and are rapidly advancing to positions of greater responsibility. In one of our bureaus we have recently seen one of the so-called weaker sex advanced by well-earned promotion to the position of chief of division.

While perhaps not quite appropriate under this heading, attention might be called to the work of the Department in cooperating with activities of the Federal Board for Vocational Education in the matter of the rehabilitation of disabled soldiers, sailors, and marines. A representative of the Department has been engaged with the board officials in considering and working out plans, and the officers and machinery of the Department's field service have been placed at the disposal of the board for the purpose of trying out candidates for rehabilitation.

Respectfully,

CLIFFORD HASTINGS,
*Chief of Appointment Division.*

To Hon. WILLIAM C. REDFIELD,
*Secretary of Commerce.*

# REPORT

OF THE

# CHIEF, DIVISION OF PUBLICATIONS

# REPORT

OF THE

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DEPARTMENT OF COMMERCE,
DIVISION OF PUBLICATIONS,
*Washington, September 8, 1919.*

SIR: The following report pertaining to the work of the Division of Publications during the fiscal year ended June 30, 1919, is respectfully submitted.

## DUTIES OF THE DIVISION.

The Division of Publications is charged with an economical expenditure of the printing and binding allotment of the Department. This responsibility involves the conduct of the business which the Department transacts with the Government Printing Office, general supervision over all printing (including the editing and preparing of copy), illustrating, and binding for the Department, and the keeping of records of expenditures and incurred liabilities. The Division has also charge of the distribution of publications; the maintenance of mailing lists; the operation of duplicating, addressing, folding, sealing, and mailing equipments; the advertising done by the Department; and the correspondence which these duties entail.

The pages following epitomize the activities of the Division along these lines.

## ALLOTMENTS AND EXPENDITURES.

The act of July 1, 1918, making appropriations for the sundry civil expenses of the Government for the fiscal year ending June 30, 1919, and for other purposes, allotted to the Department $400,000 for printing and binding during the fiscal year 1919. In addition thereto the Department's allotment was credited to the extent of $23.47 for miscellaneous blank forms furnished by the Coast and Geodetic Survey to the Chief of Engineers, War Department, thus increasing the amount to $400,023.47. Of this sum $399,961.32 was expended, leaving an unused balance on June 30 of $62.15. From allotments made to the Department from the national security and defense fund there was expended for printing and binding the sum of $5,573.96. Thus, the increase in expenditures in 1919, compared with 1918, was $10,583.04 (or 2.68 per cent), the expenditures in 1918 being $394,952.24.

During the decennial-census period of three years beginning July 1, 1919, the Bureau of the Census will not participate in the Department's printing and binding allotment, as the work for that Bureau, including the cost of completing operations on its work remaining unfinished at the close of the fiscal year 1919, will be paid for from the appropriation for the Fourteenth Census. The estimated cost of unbilled and uncompleted work of the Department, exclusive of that of the Bureau of the Census, at the Government Printing Office on July 1, 1919, and chargeable against the allotment for 1920, was $27,117.40, while such work at the Government Printing Office on the same date in 1918 actually cost $43,615.41. Including the work of the Bureau of the Census, the figures for this item for the past two years are as follows: 1919, $64,994.75; 1918, $74,882.95. There was also at the Government Printing Office at the close of the year work for the Department, estimated to cost $23,266.89, chargeable against the national security and defense fund.

During the fiscal year 1919 the Department issued on the Public Printer 2,460 requisitions for printing and binding, compared with 2,871 during the preceding fiscal year, a decrease of 411. Of the requisitions issued in 1919 there remained at the close of the fiscal year 174 on which deliveries of completed work had not been made, compared with 501 in 1918, 416 in 1917, 379 in 1916, 436 in 1915, 355 in 1914, and 344 in 1913.

## COST OF PRINTING AND BINDING, BY BUREAUS.

The following table shows the cost of printing and binding for each of the bureaus, offices, and services of the Department during the fiscal years 1918 and 1919, together with the increase or decrease for each bureau, office, and service, and the estimated cost of the work on hand but not completed June 30, 1919:

| Bureau, office, or service. | Cost of work delivered. | | Increase (+) or decrease (−). | | Estimated cost of work not completed June 30, 1919. |
|---|---|---|---|---|---|
| | 1918 | 1919 | Cost. | Per cent. | |
| Office of the Secretary (Secretary, Assistant Secretary, Solicitor, Chief Clerk, and Division of Publications) | $18,388.96 | $17,112.36 | −$1,276.60 | − 6.94 | $351.16 |
| Appointment Division | 651.23 | 645.34 | − 5.89 | − .90 | ........... |
| Disbursing Office | 564.78 | 1,101.97 | + 537.19 | + 95.11 | ........... |
| Division of Supplies | 202.55 | 344.32 | + 141.77 | + 69.99 | 58.22 |
| Bureau of the Census | 96,487.31 | 113,971.18 | +17,483.87 | + 18.12 | 37,877.35 |
| Coast and Geodetic Survey | 45,610.93 | 30,607.79 | −15,003.14 | − 32.89 | 6,456.30 |
| Bureau of Fisheries | 15,364.28 | 12,393.97 | − 2,970.31 | − 19.33 | 1,738.70 |
| Bureau of Foreign and Domestic Commerce | 118,617.02 | 120,198.30 | + 1,581.28 | + 1.33 | 13,417.94 |
| Bureau of Lighthouses | 18,586.42 | 16,595.33 | − 1,991.09 | − 10.71 | 191.13 |
| Lighthouse Service | 6,443.32 | 7,580.02 | + 1,136.70 | + 17.64 | 44.55 |
| Bureau of Navigation | 12,902.86 | 16,856.98 | + 3,954.12 | + 30.65 | 109.93 |
| Shipping Service | 3,440.45 | 5,835.92 | + 2,395.47 | + 69.63 | 170.84 |
| Radio Service | 447.29 | 635.44 | + 188.15 | + 42.06 | ........... |
| Bureau of Standards | 35,638.74 | 32,548.55 | − 3,090.19 | − 8.67 | 3,288.95 |
| Office of the Supervising Inspector General, Steamboat-Inspection Service | 1,760.34 | 1,187.98 | − 572.36 | − 32.51 | ........... |
| Steamboat-Inspection Service | 9,795.13 | 13,192.28 | + 3,397.15 | + 34.68 | 316.00 |
| Customs Service | 10,050.63 | 9,153.59 | − 897.04 | − 8.93 | 973.68 |
| Total | 394,952.24 | 399,961.32 | + 5,009.08 | + 1.27 | [a] 64,994.75 |
| Expenditures chargeable against allotments from the national security and defense fund: | | | | | |
| Waste-Reclamation Service | ........... | 684.20 | + 684.20 | +100.00 | ........... |
| Industrial Cooperation Service | ........... | 4,854.43 | + 4,854.43 | +100.00 | 10,000.00 |
| Industrial Board | ........... | 35.33 | + 35.33 | +100.00 | ........... |
| Import and Export Statistics | ........... | ........... | ........... | ........... | 13,266.89 |
| Total | ........... | 5,573.96 | + 5,573.96 | +100.00 | 23,266.89 |
| Grand total | 394,952.24 | 405,535.28 | +10,583.04 | + 2.68 | 88,261.64 |

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[a] Of this amount $37,877.35 is for work ordered by the Bureau of the Census, which will be paid for from the appropriation for the Fourteenth Census and will not be chargeable against the Department's allotment for printing and binding for 1920.

1919 the amount available to the Department for printing and binding, the amount expended, the unused balance on June 30, and the cost of work not completed at the close of the year. Figures prior to 1913 include expenditures for bureaus and services transferred to the Department of Labor by the act of March 4, 1913, but they do not include those for the Bureau of the Census, which was formerly provided for by separate allotments or appropriations. Expenditures for the Bureau of Corporations also are included in years prior to 1916.

| Fiscal year. | Allotment. | Expenditures. | Unused balance. | Cost of work not completed June 30. |
|---|---|---|---|---|
| 1907 | $375,000.00 | $332,185.05 | $42,814.95 | $34,749.24 |
| 1908 | 375,000.00 | 342,962.36 | 32,037.64 | 47,055.59 |
| 1909 | 375,000.00 | 374,939.91 | 60.09 | 29,139.26 |
| 1910 | [a] 376,337.43 | [a] 361,530.43 | 14,807.00 | 42,535.93 |
| 1911 | [b] 381,500.00 | [b] 375,575.02 | 5,924.98 | 46,173.12 |
| 1912 | 375,000.00 | 374,995.64 | 4.36 | 43,956.76 |
| 1913 | [c] 329,978.06 | [c] 329,974.92 | 3.14 | 36,686.50 |
| 1914 | 441,000.00 | 410,700.77 | 30,299.23 | 49,827.74 |
| 1915 | 400,000.00 | 399,999.47 | .53 | 55,993.72 |
| 1916 | 390,000.00 | 389,838.28 | 161.72 | 68,771.41 |
| 1917 | 400,000.00 | 382,602.76 | 17,397.24 | 69,104.73 |
| 1918 | 400,000.00 | 394,952.24 | 5,047.76 | 74,882.95 |
| 1919 | [d] 400,023.47 | [e] 399,961.32 | 62.15 | [f] 64,994.75 |

[a] Includes $1,337.43 expended for supplies furnished the Bureau of the Census, for which the Department's allotment was reimbursed.

[b] Includes a special appropriation of $6,500 for the printing of the World Trade Directory. The entire sum was expended for the publication.

[c] The Department's allotment was reimbursed for printing and binding furnished the Bureau of Navigation for the Radio Service, costing $1,716.58, from the appropriation "Enforcement of wireless-communication laws, 1913"; also for work furnished the Bureau of the Census, costing $5,011.48, of which $383.29 was reimbursed from the appropriation "Tobacco statistics, Bureau of the Census, 1913," and $4,628.19 from the appropriation "Cotton statistics, Bureau of the Census, 1913."

[d] Includes credit of $23.47 for miscellaneous blank forms furnished by the Coast and Geodetic Survey to the Chief of Engineers, War Department.

[e] During 1919 there was also an expenditure of $5,573.96 from allotments made to the Department from the national security and defense fund.

[f] Estimated. Of this amount $37,877.35 is for work ordered by the Bureau of the Census, which will be paid for from the appropriation for the Fourteenth Census, and will not be chargeable against the Department's allotment for printing and binding for 1920. There was also at the Government Printing Office at the close of the year work for the Department chargeable against the national security and defense fund estimated to cost $23,266.89.

## QUANTITY AND COST OF PRINTING AND BINDING, BY CLASSES.

The following statement shows the amount and cost of each class of work during the fiscal years 1918 and 1919. The figures for 1919 include printing and binding to the extent of $5,573.96 for services for which expenditures were chargeable against allotments from the national security and defense fund.

| | | | | |
|---|---|---|---|---|
| | *Number.* | *Number.* | *Number.* | *Per cent.* |
| Blank forms | 25,605,702 | 25,801,745 | + 196,043 | + 0.77 |
| Reports, pamphlets, etc | 4,560,340 | 3,601,129 | − 959,211 | − 21.03 |
| Letterheads | 3,360,000 | 3,464,000 | + 104,000 | + 3.10 |
| Envelopes | 58,000 | 4,324,500 | +4,266,500 | +7,356.03 |
| Circulars, summaries, and notices | 1,562,625 | 236,700 | −1,325,925 | − 84.85 |
| Index cards | 1,318,500 | 1,706,700 | + 388,200 | + 29.44 |
| Guide cards and folders | 431,817 | 265,700 | − 166,117 | − 38.47 |
| Memorandum sheets | 2,240,000 | 2,630,000 | + 390,000 | + 17.41 |
| Blank books | 24,578 | 69,629 | + 45,051 | + 183.30 |
| Miscellaneous books (binding) | 2,819 | 2,288 | − 531 | − 18.83 |
| | *Cost.* | *Cost.* | *Cost.* | *Per cent.* |
| Blank forms | $52,441.17 | $58,650.45 | +$6,209.28 | + 11.82 |
| Reports, pamphlets, etc | 305,761.33 | 305,279.76 | − 481.57 | − .16 |
| Letterheads | 5,380.60 | 6,253.41 | + 872.81 | + 16.22 |
| Envelopes | 146.97 | 1,754.21 | + 1,607.24 | +1,093.58 |
| Circulars, summaries, and notices | 4,083.13 | 1,703.62 | − 2,379.51 | − 58.56 |
| Index cards | 1,153.60 | 2,167.73 | + 1,014.13 | + 87.91 |
| Guide cards and folders | 2,779.80 | 1,792.98 | − 986.82 | − 35.50 |
| Memorandum sheets | 2,122.46 | 1,832.86 | − 289.60 | − 18.18 |
| Blank books | 14,348.41 | 20,022.95 | + 5,674.54 | + 39.55 |
| Miscellaneous books (binding) | 6,055.63 | 5,116.37 | − 939.26 | − 15.51 |
| Miscellaneous | 679.14 | 960.94 | + 281.80 | + 41.49 |
| Total | 394,952.24 | 405,535.28 | +10,583.04 | + 2.68 |

The following table gives the cost of work during the fiscal years 1918 and 1919, by classes and by bureaus, offices, and services:

| Bureau, office, or service. | Blank forms. | | Reports, pamphlets, etc. | | Letterheads. | |
|---|---|---|---|---|---|---|
| | 1918 | 1919 | 1918 | 1919 | 1918 | 1919 |
| Office of the Secretary (Secretary, Assistant Secretary, Solicitor, Chief Clerk, and Division of Publications) | $1,313.59 | $1,527.19 | $7,649.63 | $6,919.15 | $1,116.45 | $690.90 |
| Appointment Division | 350.61 | 460.29 | 54.74 | 51.56 | 13.96 | 9.70 |
| Disbursing Office | 501.87 | 1,060.98 | .......... | .......... | .......... | 10.63 |
| Division of Supplies | 185.86 | 284.27 | .......... | .......... | 9.65 | 18.24 |
| Bureau of the Census | 19,976.97 | 27,198.52 | 74,994.00 | 81,576.83 | 426.96 | 1,589.69 |
| Coast and Geodetic Survey | 1,953.18 | 2,783.92 | 41,512.61 | 25,866.91 | 256.13 | 124.51 |
| Bureau of Fisheries | 993.71 | 1,527.02 | 11,262.47 | 8,971.20 | 136.98 | 147.68 |
| Bureau of Foreign and Domestic Commerce | 5,707.20 | 2,218.91 | 108,632.93 | 115,064.35 | 1,410.78 | 942.25 |
| Bureau of Lighthouses | 22.98 | 29.97 | 18,405.01 | 16,288.07 | 16.51 | 89.24 |
| Lighthouse Service | 3,433.16 | 2,988.67 | 96.19 | 385.08 | 650.81 | 661.24 |
| Bureau of Navigation | 335.12 | 251.03 | 12,435.29 | 16,228.54 | 46.14 | 68.14 |
| Shipping Service | 811.67 | 3,259.75 | .......... | .......... | 61.14 | 60.16 |
| Radio Service | 413.74 | 458.79 | .......... | .......... | 33.55 | 56.32 |
| Bureau of Standards | 5,275.12 | 5,778.19 | 24,222.67 | 19,691.43 | 787.44 | 1,226.73 |
| Office of Supervising Inspector General, Steamboat-Inspection Service | 1,138.24 | 403.56 | 547.83 | 723.70 | 31.04 | 40.68 |
| Steamboat-Inspection Service | 3,543.91 | 2,895.05 | 5,864.60 | 8,057.19 | 383.06 | 437.16 |
| Customs Service | 6,484.24 | 5,524.34 | 83.36 | .......... | .......... | .......... |
| Total | 52,441.17 | 58,650.45 | 305,761.33 | 299,824.01 | 5,380.60 | 6,173.27 |
| Services for which expenditures were chargeable against allotments from the national security and defense fund: | | | | | | |
| Waste-Reclamation Service | .......... | .......... | .......... | 633.05 | .......... | 23.04 |
| Industrial Cooperation Service | .......... | .......... | .......... | 4,822.70 | .......... | 31.73 |
| Industrial Board | .......... | .......... | .......... | .......... | .......... | 25.37 |
| Total | .......... | .......... | .......... | 5,455.75 | .......... | 80.14 |
| Grand total | 52,441.17 | 58,650.45 | 305,761.33 | 305,279.76 | 5,380.60 | 6,253.41 |

|  | 1918 | 1919 | 1918 | 1919 | 1918 | 1919 | 1918 | 1919 |
|---|---|---|---|---|---|---|---|---|
| Office of the Secretary (Secretary, Assistant Secretary, Solicitor, Chief Clerk, and Division of Publications). | $6.30 | $387.30 | $2,189.41 | $1,423.04 | $189.60 | $836.77 | $927.83 | $720.18 |
| Appointment Division |  |  |  |  |  |  | 45.42 |  |
| Disbursing Office |  | 2.25 |  |  |  |  |  |  |
| Bureau of the Census |  | 1,197.07 | 10.58 |  | 8.32 |  | 88.73 |  |
| Coast and Geodetic Survey | 31.51 | 6.15 | 3.28 |  | 3.85 | 16.47 | 6.64 | 6.77 |
| Bureau of Fisheries |  |  | 1,788.48 | 205.91 | 29.38 |  |  | 5.33 |
| Bureau of Foreign and Domestic Commerce | 74.96 | 80.80 | 4.04 |  | 277.20 | 48.90 | 702.49 | 81.04 |
| Bureau of Lighthouses | 2.50 |  | 77.25 | 72.65 | 11.45 | 5.85 |  |  |
| Lighthouse Service | 12.30 |  | 10.09 | 2.02 | 13.83 | 9.16 | 284.81 | 1.01 |
| Bureau of Navigation | 9.80 | 5.38 |  |  |  |  | 39.29 |  |
| Radio Service |  |  |  |  |  |  |  | 5.03 |
| Bureau of Standards | 9.60 | 37.19 |  |  | 619.97 | 1,250.58 | 664.45 | 973.62 |
| Office of the Supervising Inspector General, Steamboat-Inspection Service |  |  |  |  |  |  | 16.58 |  |
| Steamboat-Inspection Service |  |  |  |  |  |  | 3.56 |  |
| Total | 146.97 | 1,716.14 | 4,083.13 | 1,703.62 | 1,153.60 | 2,167.73 | 2,779.80 | 1,792.98 |
| Services for which expenditures were chargeable against allotments from the national security and defense fund: |  |  |  |  |  |  |  |  |
| Waste-Reclamation Service |  | 28.11 |  |  |  |  |  |  |
| Industrial Board |  | 9.96 |  |  |  |  |  |  |
| Total |  | 38.07 |  |  |  |  |  |  |
| Grand total | 146.97 | 1,754.21 | 4,083.13 | 1,703.62 | 1,153.60 | 2,167.73 | 2,779.80 | 1,792.98 |

| Bureau, office, or service. | Memorandum sheets. |  | Blank books. |  | Miscellaneous books (binding). |  | Miscellaneous. |  |
|---|---|---|---|---|---|---|---|---|
|  | 1918 | 1919 | 1918 | 1919 | 1918 | 1919 | 1918 | 1919 |
| Office of the Secretary (Secretary, Assistant Secretary, Solicitor, Chief Clerk, and Division of Publications) | $1,406.05 | $1,513.04 | $2,274.88 | $1,926.51 | $810.30 | $1,002.15 | $504.92 | $166.13 |
| Appointment Division |  |  | 21.46 |  | 165.04 |  |  | 123.79 |
| Disbursing Office |  |  | 62.91 | 28.11 |  |  |  |  |
| Division of Supplies |  |  |  | 41.81 | 7.04 |  |  |  |
| Bureau of the Census | 667.96 | 319.82 | 67.16 | 1,775.06 | 190.44 | 9.59 | 56.19 | 304.60 |
| Coast and Geodetic Survey |  |  | 1,421.47 | 1,132.01 | 418.83 | 637.97 |  | 33.08 |
| Bureau of Fisheries |  |  | 297.29 | 873.23 | 855.97 | 660.00 |  | 3.60 |
| Bureau of Foreign and Domestic Commerce |  |  | 417.29 | 679.99 | 1,292.10 | 1,056.26 | 98.03 | 25.80 |
| Bureau of Lighthouses |  |  | 24.58 | 34.81 | 29.57 | 43.03 |  | 31.71 |
| Lighthouse Service |  |  | 1,918.19 | 3,479.73 | 23.94 | 53.11 |  |  |
| Bureau of Navigation |  |  | 4.56 | 296.15 | 32.66 | 7.74 |  |  |
| Shipping Service |  |  | 2,005.16 | 2,516.01 | 562.48 |  |  |  |
| Radio Service |  |  |  | 115.30 |  |  |  |  |
| Bureau of Standards | 48.45 |  | 2,350.43 | 1,692.10 | 1,640.61 | 1,626.48 | 20.00 | 272.23 |
| Office of Supervising Inspector General, Steamboat-Inspection Service |  |  |  |  | 26.65 | 20.04 |  |  |
| Steamboat-Inspection Service. |  |  |  | 1,802.88 |  |  |  |  |
| Customs Service |  |  | 3,483.03 | 3,629.25 |  |  |  |  |
| Total | 2,122.46 | 1,832.86 | 14,348.41 | 20,022.95 | 6,055.63 | 5,116.37 | 679.14 | 960.94 |

## PUBLICATIONS ISSUED.

There is submitted on the following pages a list of publications issued by the Department during the last fiscal year and the number of each distributed up to July 1, 1919. Some of the publications listed were received too late for general distribution before the end which the Department's allotment for printing and binding was drawn upon, in accordance with the provisions of Public Resolution No. 13, approved March 30, 1906.

## PUBLICATIONS ISSUED BY DEPARTMENT OF COMMERCE, AND DISTRIBUTION THEREOF, FISCAL YEAR 1919.

[Unless otherwise stated, size of each publication is 5⅞ by 9⅛ inches.]

### OFFICE OF THE SECRETARY.

| Title and description. | Received. | Distributed. | Cost. |
|---|---|---|---|
| Annual report of Secretary, 1918. 157 p. | 3,000 | 1,462 | $765.15 |
| Same [press proof; extracts from]. 41 l. | 2,800 | 2,800 | 184.40 |
| Annual report of Chief, Appointment Division, 1918. 14 p. | 350 | 302 | 51.56 |
| Annual report of Chief, Division of Publications, 1918. [Printed also as H. doc. 1587, 65th Cong. 3d sess.] 31 p. | 400 | 167 | 218.03 |
| Reports of Department, 1918. Report of Secretary and reports of bureaus [consolidated]. [Printed also as H. doc. 1621, 65th Cong. 3d sess.] 886 p. 1 paster. | 500 | 273 | 1,473.71 |
| List of publications of Department available for distribution. 17th edition. May 1, 1919. 78 p. | 10,000 | 4,837 | 606.81 |
| Monthly list of publications issued by Department [June, 1918–May, 1919, 12 numbers]. 41 p. | 59,400 | 59,400 | 267.42 |
| Department circulars [all 8x10½"]: | | | |
| 213, 3d edition—Bureau of Lighthouses. Rules and regulations governing private aids to navigation. Sept. 24, 1918. 2 p. | 2,000 | 400 | 16.62 |
| 230, 2d edition—Bureau of Navigation. Rules to prevent collisions of vessels. June 8, 1917. [Reprint.] 17 p. | 50,000 | 22,600 | 724.94 |
| 236, 6th edition—Bureau of Navigation and Steamboat-Inspection Service. Regulation of motor boats. Jan. 25, 1918. 4 p. | 300,000 | 155,000 | 1,040.88 |
| 246, 6th edition—Bureau of Fisheries. Regulations for protection of fur-bearing animals in Alaska. Sept. 30, 1918. 3 p. | 2,500 | 1,925 | 17.82 |
| 247—Bureau of Navigation. Rules and regulations to promote safety of life on navigable waters during regattas or marine parades. May 19, 1913. [Reprint.] 2 p. | 1,000 | 300 | 4.41 |
| 251, 5th edition—Bureau of Fisheries. Laws and regulations for protection of fisheries of Alaska. Jan. 14, 1919. 10 p. | 3,500 | 3,500 | 97.62 |
| Same [reprint]. | 1,500 | 915 | 51.03 |
| 253, 2d edition. Illegal collection or payment of political assessments and forms of political activity forbidden by civil-service law and rules. Sept. 22, 1914. [Reprint.] 2 p. | 3,000 | 1,500 | 11.34 |
| 265, 2d edition—Bureau of Navigation. Language test under seamen's act. July 1, 1919. 2 p. | 5,000 | 1,000 | 18.91 |
| 278—Bureau of Navigation. Numbering and recording undocumented vessels. June 17, 1918. 1 p. | 300,000 | 237,000 | 223.13 |
| Same [reprint]. | 150,000 | .......... | 142.17 |
| 279. Regulations regarding contract brokers, contingent-fee operators, and nonmanufacturing dealers. June 21, 1918. 1 p. | 3,000 | 1,200 | 11.88 |
| Same, 2d edition [with changes]. May 19, 1919. 1 p. | 1,500 | 605 | 8.28 |
| Organization of Department. [List of officials.] (Corrected to Oct. 1, 1918.) 1 p. 4¼x6½". | 100 | 100 | 4.51 |
| Same. (Corrected to Jan. 27, 1919.) 1 p. 4¼x6½". | 300 | 100 | 4.95 |
| Process Co. *v.* Delaware, Lackawanna, and Western Railroad Co. and William G. McAdoo, Director General of Railroads. Brief of William C. Redfield, Secretary of Commerce, intervenor, before Interstate Commerce Commission. 21 p. | 500 | 330 | 50.04 |
| Atlantic intracoastal canals; Commercial, military, and other advantages of deep sea-level canals connecting North Atlantic coastal waterways [with bibliography]. Prepared in Bureau of Foreign and Domestic Commerce by Grosvenor M. Jones and Oliver C. Moles. [Printed also as S. doc. 279, 65th Cong. 2d sess.] 139 p. 3 pl. 1 map, 5 text fig. | 500 | 473 | 67.34 |
| Same [reprint]. | 500 | .......... | 69.98 |
| International price comparisons—History of prices during war [with bibliography]; by Wesley C. Mitchell, assisted by Margaret L. Goldsmith and Florence K. Middaugh. [Published by Department of Commerce in cooperation with War Industries Board.] 408 p. 22 text fig. | 3,000 | 1,729 | 4,822.70 |
| Waste reclamation: Organization, functions, and objects of national and local service. 19 p. | 35,000 | 13,400 | 364.39 |
| Report of an investigation of Akron Industrial Salvage Co. 20 p. | 15,000 | 13,000 | 185.83 |
| Same [reprint]. | 10,000 | .......... | 82.83 |

| Title and description. | Received. | Distributed. | Cost. |
|---|---|---|---|
| Letter from Acting Secretary of Treasury, transmitting copy of communication from Secretary of Commerce submitting supplemental estimate of appropriation required by Lighthouse Service for lighthouse depot and equipment for 16th lighthouse district, Alaska. [Printed as S. doc. 243, 65th Cong. 2d sess.] 2 p. | (a) | (a) | $4.40 |
| Letter from Acting Secretary of Treasury, transmitting copy of communication from Secretary of Commerce submitting supplemental estimate of appropriation required by Lighthouse Service for salaries of keepers of lighthouses, fiscal year 1919. [Printed as S. doc. 254, 65th Cong. 2d sess.] 2 p. | (a) | (a) | 4.40 |
| Letter from Acting Secretary of Treasury, transmitting copy of communication from Secretary of Commerce submitting deficiency estimate of appropriation in sum of $4,750, required by Bureau of Standards to cover deficiency in appropriation "Testing railroad scales, etc., Bureau of Standards, 1917." [Printed as S. doc. 255, 65th Cong. 2d sess.] 2 p. | (a) | (a) | 4.40 |
| Letter from Secretary of Commerce, transmitting letter relating to purchase of land by Bureau of Standards in District of Columbia. [Printed as H. doc. 1188, 65th Cong. 2d sess.] 4 p. | (a) | (a) | 10.02 |
| Letter from Secretary of Commerce, inviting attention to certain items of public works relating to Lighthouse Service, with a view of their inclusion in next deficiency appropriation bill. [Printed as H. doc. 1205, 65th Cong. 2d sess.] 2 p. | (a) | (a) | 4.40 |
| Letter from Acting Secretary of Treasury, transmitting copy of communication from Secretary of Commerce submitting supplemental estimates of appropriations required by Steamboat-Inspection Service for fiscal year 1919. [Printed as H. doc. 1236, 65th Cong. 2d sess.] 3 p. | (a) | (a) | 16.47 |
| Letter from Acting Secretary of Treasury, transmitting communication from Acting Secretary of Commerce submitting supplemental estimate of appropriation required by Steamboat-Inspection Service for fiscal year 1919. [Printed as H. doc. 1269, 65th Cong. 2d sess.] 2 p. | (a) | (a) | 9.86 |
| Letter from Acting Secretary of Commerce, transmitting an estimate in sum of $9,600 supplemental to appropriation of $380,000 for salaries, Lighthouse Service, 1919. [Printed as H. doc. 1271, 65th Cong. 2d sess.] 2 p. | (a) | (a) | 5.16 |
| Letter from Acting Secretary of Treasury, transmitting copy of communication from Secretary of Commerce submitting supplemental estimates of appropriation required by Bureau of Standards for fiscal year 1919. [Printed as H. doc. 1292, 65th Cong. 2d sess.] 2 p. | (a) | (a) | 8.26 |
| Letter from Acting Secretary of Treasury, transmitting copy of communication from Secretary of Commerce submitting deficiency estimate of appropriation required by Bureau of Fisheries for fiscal year 1919. [Printed as H. doc. 1321, 65th Cong. 2d sess.] 2 p. | (a) | (a) | 4.92 |
| Letter from Acting Secretary of Commerce, transmitting statement of expenditures in Department of Commerce, fiscal year 1918. [Printed as H. doc. 1561, 65th Cong. 3d sess.] 91 p. | (a) | (a) | 733.96 |
| Letter from Secretary of Treasury, transmitting copy of communication from Acting Secretary of Commerce submitting supplemental estimate of appropriation required by Department of Commerce for fiscal year 1920. [Printed as H. doc. 1566, 65th Cong. 3d sess.] 5 p. | (a) | (a) | 27.95 |
| Letter from Secretary of Treasury, transmitting copy of communication from Acting Secretary of Commerce submitting supplemental estimate of appropriation required by Department of Commerce for fiscal year 1919. [Printed as H. doc. 1567, 65th Cong. 3d sess.] 4 p. | (a) | (a) | 18.84 |
| Letter from Secretary of Commerce, inviting attention to items in estimates of appropriations for Lighthouse Service for fiscal year 1920. [Printed as H. doc. 1572, 65th Cong. 3d sess.] 10 p. | (a) | (a) | 23.10 |
| Letter from Secretary of Commerce, transmitting copy of report of Chief of Division of Publications of Department for fiscal year 1918, which contains detailed statement of publications received and number distributed during fiscal year 1918. [Printed as H. doc. 1587, 65th Cong. 3d sess.] 31 p. | (a) | (a) | 4.76 |
| Letter from Secretary of Treasury, transmitting copy of communication from Secretary of Commerce submitting supplemental estimate of appropriations required by Bureau of Foreign and Domestic Commerce. [Printed as H. doc. 1597, 65th Cong. 3d sess.] 2 p. | (a) | (a) | 4.12 |
| Letter from Secretary of Commerce, transmitting report of board of visitors to Bureau of Standards. [Printed as H. doc. 1603, 65th Cong. 3d sess.] 4 p. | (a) | (a) | 8.44 |
| Letter from Secretary of Commerce, transmitting statement of expenditures in Coast and Geodetic Survey for fiscal year 1918. [Printed as H. doc. 1608, 65th Cong. 3d sess.] 16 p. | (a) | (a) | 112.46 |
| Letter from Secretary of Treasury, transmitting copy of communication from Secretary of Commerce submitting supplemental estimate of appropriations required by Department of Commerce for reclamation of waste materials, fiscal year 1920. [Printed as H. doc. 1615, 65th Cong. 3d sess.] 2 p. | (a) | (a) | 4.12 |

[a] None printed for the Department.

| Title and description. | Received. | Distributed. | Cost. |
|---|---|---|---|
| Letter from Secretary of Treasury, transmitting copy of letter from Secretary of Commerce submitting estimate of appropriation required for certain light stations for fiscal year 1920. [Printed as H. doc. 1617, 65th Cong. 3d sess.] 3 p | (a) | (a) | $7.74 |
| Letter from Secretary of Treasury, transmitting copy of communication from Secretary of Commerce submitting supplemental estimate of appropriation required for Department of Commerce for fiscal year 1919. [Printed as H. doc. 1680, 65th Cong. 3d sess.] 2 p | (a) | (a) | 5.16 |
| Letter from Secretary of Treasury, transmitting copy of communication from Secretary of Commerce submitting supplemental estimate of appropriation required by Bureau of Fisheries for fiscal year 1919. [Printed as H. doc. 1683, 65th Cong. 3d sess.] 2 p | (a) | (a) | 4.92 |
| Letter from Acting Secretary of Commerce, transmitting report of an accumulation of documents and files of papers not needed or useful in transaction of current business of Department and which have no permanent value or historical interest. [Printed as H. doc. 1693, 65th Cong. 3d sess.] 8 p | (a) | (a) | 23.28 |
| Letter from Secretary of Treasury, transmitting copy of communication from Acting Secretary of Commerce submitting paragraph of legislation providing that unexpended balance of appropriation for developing aquatic sources of leather made by act of June 12, 1917, be continued and made available for fiscal year 1920. [Printed as H. doc. 1708, 65th Cong. 3d sess.] 2 p | (a) | (a) | 4.92 |
| Letter from Secretary of Treasury, transmitting copy of communication from Secretary of Commerce submitting supplemental estimate of appropriation required by Bureau of Fisheries for employment of instructors in Alaskan herring industry. [Printed as H. doc. 1719, 65th Cong. 3d sess.] 2 p | (a) | (a) | 4.92 |
| Letter from Secretary of Treasury, transmitting copy of communication from Acting Secretary of Commerce submitting paragraph of legislation extending for fiscal year 1920 the unexpended balance of appropriation made by act of July 3, 1918, for punching machines, Fourteenth Census. [Printed as H. doc. 1720, 65th Cong. 3d sess.] 2 p | (a) | (a) | 3.96 |
| Letter from Secretary of Treasury, transmitting copy of communication from Secretary of Commerce submitting supplemental estimate of appropriation required by Bureau of Fisheries to reimburse fish packers for certain losses. [Printed as H. doc. 1736, 65th Cong. 3d sess.] 4 p | (a) | (a) | 8.60 |
| Letter from Secretary of Treasury, transmitting copy of communication from Secretary of Commerce submitting supplemental estimate of appropriation required to complete pending purchase of land for Bureau of Standards. [Printed as H. doc. 1744, 65th Cong. 3d sess.] 2 p | (a) | (a) | 5.16 |
| Letter from Acting Secretary of Treasury, transmitting copy of communication from Secretary of Commerce submitting supplemental estimate of appropriation required by Department of Commerce for fiscal year 1919. [Printed as H. doc. 1792, 65th Cong. 3d sess.] 5 p | (a) | (a) | 15.15 |
| Letter from Acting Secretary of Treasury, transmitting copy of communication from Acting Secretary of Commerce submitting deficiency estimate of appropriation required by Bureau of Fisheries for power lighter for Alaska fur-seal islands for fiscal year 1919. [Printed as H. doc. 1800, 65th Cong. 3d sess.] 2 p | (a) | (a) | 4.12 |
| Letter from Secretary of Commerce, transmitting summary of reports from collectors of customs and brief statement of action of Department, both with respect to accidents sustained by barges while in tow through open sea during fiscal year 1918. [Printed as H. doc. 1825, 65th Cong. 3d sess.] 11 p | (a) | (a) | 32.21 |
| Letter from Secretary of Treasury, transmitting copy of communication from Acting Secretary of Commerce submitting deficiency estimate of appropriation required for contingent expenses of Steamboat-Inspection Service for fiscal year 1919. [Printed as S. doc. 42, 66th Cong. 1st sess.] 3 p | (a) | (a) | 6.30 |
| Letter from Secretary of Treasury, transmitting copy of communication from Secretary of Commerce submitting deficiency estimate of appropriation required by Department of Commerce to cover increased cost of envelopes for fiscal year 1918. [Printed as H. doc. 14, 66th Cong. 1st sess.] 2 p | (a) | (a) | 4.92 |
| Letter from Secretary of Treasury, transmitting copy of communication from Secretary of Commerce submitting supplemental estimates of appropriations required by Coast and Geodetic Survey for fiscal year 1920. [Printed as H. doc. 16, 66th Cong. 1st sess.] 6 p | (a) | (a) | 21.96 |
| Letter from Secretary of Treasury, transmitting copy of communication from Secretary of Commerce submitting supplemental estimate of appropriation required by Coast and Geodetic Survey for expenses of vessels and launches assigned to Survey by Executive order. [Printed as H. doc. 18, 66th Cong. 1st sess.] 2 p | (a) | (a) | 5.16 |
| Letter from Secretary of Treasury, transmitting copy of communication from Secretary of Commerce submitting supplemental estimate of appropriation required by Lighthouse Service for completing Conneaut Light Station, Ohio. [Printed as H. doc. 19, 66th Cong. 1st sess.] 2 p | (a) | (a) | 5.16 |

[a] None printed for the Department.

## OFFICE OF THE SECRETARY—Continued.

| Title and description. | Received. | Distributed. | Cost. |
|---|---|---|---|
| Letter from Secretary of Treasury, transmitting copy of communication from Secretary of Commerce submitting supplemental estimate of appropriation required by Bureau of Fisheries for miscellaneous expenses of Bureau and improvement at stations, fiscal year 1920. [Printed as H. doc. 22, 66th Cong. 1st sess.] 4 p | (a) | (a) | $16.04 |
| Letter from Secretary of Commerce, transmitting certain data regarding estimates of appropriations required by Bureau of Fisheries for fiscal year 1920. [Printed as H. doc. 23, 66th Cong. 1st sess.] 6 p | (a) | (a) | 13.86 |
| Letter from Secretary of Commerce, inviting attention to certain items in estimates of appropriation for Bureau of Foreign and Domestic Commerce for fiscal year 1920. [Printed as H. doc. 25, 66th Cong. 1st sess.] 4 p | (a) | (a) | 8.44 |
| Letter from Secretary of Commerce, transmitting estimate of appropriation for constructing or purchasing and equipping lighthouse tenders and light vessels to replace vessels worn out in service in 3d, 5th, and 8th lighthouse districts or for use in Lighthouse Service generally. [Printed as H. doc. 47, 66th Cong. 1st sess.] 5 p | (a) | (a) | 11.15 |
| Letter from Secretary of Commerce, requesting passage of certain legislation for aids to navigation and for other works in Lighthouse Service, and for other purposes. [Printed as H. doc. 48, 66th Cong. 1st sess.] 3 p | (a) | (a) | 6.30 |
| Letter from Secretary of Treasury, transmitting communication from Secretary of Commerce submitting supplemental estimates of appropriations required by Bureau of Standards for research and investigations for fiscal year 1920. [Printed as H. doc. 56, 66th Cong. 1st sess.] 4 p | (a) | (a) | 22.84 |
| Letter from Secretary of Treasury, transmitting copy of communication from Secretary of Commerce submitting supplemental estimate of appropriation required by Bureau of Fisheries for Fairport, Iowa, biological station, fiscal year 1920. [Printed as H. doc. 63, 66th Cong. 1st sess.] 3 p | (a) | (a) | 6.54 |
| Letter from Secretary of Commerce, transmitting report on handling and disposal of waste paper in Government service, together with certain comments thereon from Office of the Public Printer and reply of Department of Commerce. [Printed as H. doc. 87, 66th Cong. 1st sess.] 19 p | (a) | (a) | 61.59 |
| Letter from Secretary of Treasury, transmitting copy of communication from Secretary of Commerce submitting supplemental estimate of appropriation required by Bureau of Fisheries for conducting demonstrations and instructions in methods of preparing fish, fiscal year 1920. [Printed as H. doc. 88, 66th Cong. 1st sess.] 4 p | (a) | (a) | 8.60 |
| Letter from Secretary of Treasury, transmitting copy of communication from Secretary of Commerce submitting supplemental estimates of appropriation required by Bureau of Navigation for fiscal year 1920. [Printed as H. doc. 125, 66th Cong. 1st sess.] 10 p | (a) | (a) | 30.30 |

## BUREAU OF THE CENSUS.

| Title and description. | Received. | Distributed. | Cost. |
|---|---|---|---|
| Annual report of Director, 1918. 28 p | 2,500 | 2,367 | $146.91 |
| Act providing for Fourteenth Census. [Reprint of Public Act 325, 65th Cong.] 23 p | 1,000 | 500 | 93.03 |
| Supervisors' districts, Fourteenth Census, 1920. 1st edition. Mar. 29, 1919. 75 p. 51 maps. 9x11½" | 2,000 | 1,142 | 498.16 |
| Instructions to enumerators, Okmulgee County, Okla. Aug. 15, 1918. 21 p. 4¾x6¾" | 300 | 300 | 36.34 |
| Special census of population of Okmulgee County, Okla. Aug. 15, 1918. 16 p | 500 | 120 | 83.12 |
| Special census of population of Ottawa County, Okla. Dec. 16, 1918. 15 p | 500 | 362 | 74.34 |
| Special census of population of Tulsa County, Okla. Jan. 15, 1919. 19 p | 800 | 398 | 101.32 |
| Census of Virgin Islands of United States. Nov. 1, 1917. 174 p. 13 pl. 2 maps, 15 text fig | 4,000 | 3,233 | 1,857.59 |
| Census publications available for distribution. Apr. 1, 1919. 16 p. 5¾x8½" | 500 | 200 | 41.54 |
| Census of manufactures, 1914: Vol. I, Reports by States, with statistics for principal cities and metropolitan districts. 1,677 p. 16 text fig. 9x11½" | 1,500 | 1,160 | 3,365.59 |
| Same: Vol. II, Reports for selected industries and detail statistics for industries, by States. 1,047 p. 6 maps, 14 text fig. 9x11½' | 1,500 | 115 | 4,626.69 |
| Same: Textiles, including cotton manufactures, wool manufactures, hosiery and knit goods, silk manufactures, and miscellaneous textiles. 165 p. 7 text fig. 9x11½" | 500 | 94 | 261.33 |
| Census of shipbuilding (including boat building), 1916 and 1914. 35 p. 9x11½" | 2,500 | 2,071 | 536.33 |
| Census of war commodities [all 9x11½"]: | | | |
| Antimony and graphite crucibles. 10 p. 9 text fig | 500 | 325 | 81.68 |
| Iron and steel products. 16 p. 8 text fig | 1,500 | 1,005 | 203.46 |
| Statistics of leather. 11 p | 1,000 | 968 | 215.24 |
| Textile fibers, wool, silk, jute, and kapok. 16 p. 20 text fig | 1,500 | 1,029 | 180.79 |

[a] None printed for the Department.

## PUBLICATIONS ISSUED BY DEPARTMENT OF COMMERCE, AND DISTRIBUTION THEREOF, FISCAL YEAR 1919—Continued.

### BUREAU OF THE CENSUS—Continued.

| Title and description. | Received. | Distributed. | Cost. |
|---|---|---|---|
| Stocks of leaf tobacco and American production, import, export, and consumption of tobacco and tobacco products, 1917. (Bulletin 136.) 44 p. 1 text fig | 20,000 | 19,984 | $634.80 |
| Cotton production and distribution, season of 1917-18. (Bulletin 137.) 135 p. 14 text fig | 37,500 | 37,050 | 2,891.57 |
| Estimates of population of United States, 1910-1917, including results of State enumerations made in 1915. (Bulletin 138.) 57 p. 2 text fig. 9x11½" | 3,000 | 1,442 | 1,012.35 |
| Cotton production in United States, crop of 1917. 39 p | 42,600 | 40,798 | 868.81 |
| Same, crop of 1918. 39 p | 36,000 | 32,434 | 837.50 |
| Birth statistics for registration area of United States, 1916. 2d annual report. 96 p. 9x11½" | 5,000 | 3,879 | 2,103.28 |
| Same [press summary]. 1 p. 9x11½" | 3,500 | 3,500 | 12.78 |
| Statistics of fire departments of cities having population of over 30,000, 1917. 105 p. 1 map | 6,000 | 5,150 | 2,176.14 |
| Financial statistics of cities having a population of over 30,000, 1917. 373 p. 29 diag. 1 map. 9x11½" | 6,500 | 6,307 | 8,727.04 |
| Financial statistics of States, 1917. 129 p. 9x11½" | 3,500 | 3,484 | 2,310.16 |
| Manual of international list of causes of death. [Based on second decennial revision by international commission, Paris, July 1 to 3, 1909.] 3d reprint. 309 p | 500 | 211 | 230.88 |
| Marriage and divorce, 1916. 50 p. 9x11½" | 5,000 | 3,129 | 909.66 |
| Mortality statistics, 1916. 17th annual report. 543 p. 10 text fig. 9x11½" | 5,000 | 4,336 | 11,718.72 |
| Negro population, 1790-1915. 844 p. 39 diag. 44 maps. 9x11½" | 5 000 | 4,253 | 17,190.87 |
| Official register, 1919: Key to abbreviations. 14 p. 9x11½" | 200 | 200 | 137.42 |
| Prisoners and juvenile delinquents in United States, 1910. 535 p. 9x11½" | 4,000 | 2,244 | 11,606.81 |
| Proposal and contract for alterations, repairs, construction work, etc. 12 p. | 500 | 500 | 55.66 |
| Specified sources of municipal revenue, including special assessments, business taxes other than on liquor traffic, general license taxes, and license taxes on dogs, in cities having a population of over 30,000, 1917. 140 p. 1 map. 9x11½" | 6,000 | 5,358 | 3,237.09 |
| Thirteenth Census of United States taken in year 1910 [all 9x11½"]: | | | |
| Vol. I, Population—General report and analysis. [Reprint.] 1,369 p. 3 pl. 10 p. of pl. 25 maps, 62 text fig | 250 | 27 | 972.18 |
| Number and distribution of inhabitants. [Reprint of Chap. I, p. 21-124, Vol. I.] [Reprint.] 111 p. 14 maps, 8 text fig | 500 | 50 | 102. 5 |
| Vol. II, Population—Reports by States, with statistics for counties, cities, and other civil divisions, Alabama-Montana. [Reprint.] 1,160 p. 1 pl. 70 maps | 200 | 12 | 702.15 |
| Vol. III, Population—Reports by States, with statistics for counties, cities, and other civil divisions, Nebraska, Wyoming, Alaska, Hawaii, and Porto Rico. [Reprint.] 1,225 p. 75 maps | 200 | .......... | 696.53 |
| Vol. IV, Population—Occupation statistics. [Reprint.] 615 p. 9 maps | 250 | 12 | 435.95 |
| Vol. V, Agriculture, 1909 and 1910—General report and analysis. [Reprint.] 927 p. 15 pl. 44 p. of pl. 62 maps, 48 text fig | 300 | 5 | 910.42 |
| Individual crops. [Reprint of Chap. IX, p. 565-734, Vol. V.] [Reprint.] 196 p. 31 maps, 15 text fig | 500 | .......... | 165.91 |
| Vol. VI, Agriculture, 1909 and 1910—Reports by States, with statistics for counties, Alabama-Montana. [Reprint.] 977 p. 30 maps. | 250 | .......... | 621.05 |
| Vol. VII, Agriculture, 1909 and 1910—Reports by States, with statistics for counties, Nebraska-Wyoming, Alaska, Hawaii, and Porto Rico. [Reprint.] 1,013 p. 34 maps | 225 | .......... | 621.81 |
| Vol. VIII, Manufactures, 1909—General report and analysis. [Reprint.] 845 p. 1 map, 37 text fig | 150 | 4 | 461.71 |
| Vol. IX, Manufactures, 1909—Reports by States, with statistics for principal cities. [Reprint.] 1,404 p | 125 | .......... | 688.39 |
| Vol. X, Manufactures, 1909—Reports for principal industries. [Reprint.] 979 p. 25 maps, 17 text fig | 100 | .......... | 456.96 |
| Vol. XI, Mines and quarries, 1909—General report and analysis. [Reprint.] 369 p. 5 maps, 7 text fig | 200 | 18 | 271.66 |
| Statistics for Kansas, containing statistics of population, agriculture, manufactures, and mining for the State, counties, cities, and other divisions. [Reprint of supplement for Kansas in connection with Abstract of Census.] 146 p. 4 maps | 300 | .......... | 130.73 |

### COAST AND GEODETIC SURVEY.

| | | | |
|---|---|---|---|
| Annual report of Superintendent, 1918. [Printed also as H. doc. 1436, 65th Cong. 3d sess.] 133 p. 2 pl. 4 p. of pl. 31 litho | 2,500 | 2,274 | $1,749.60 |
| General tide tables, [calendar] year 1919. (Serial 95.) 497 p. 6 diag. 1 text fig | 4,000 | 3,693 | 2,716.60 |

## PUBLICATIONS ISSUED BY DEPARTMENT OF COMMERCE, AND DISTRIBUTION THEREOF, FISCAL YEAR 1919—Continued.

### COAST AND GEODETIC SURVEY—Continued.

| Title and description. | Received. | Distributed. | Cost. |
|---|---|---|---|
| Atlantic coast tide tables for eastern North America, [calendar] year 1919; from General tide tables. (Serial 80.) 190 p. 6 diag. 1 text fig. | 7,000 | 3,694 | $2,418.23 |
| Same, [calendar] year 1920; from General tide tables. (Serial 103.) 200 p. 6 diag. 1 text fig. | 7,000 | 191 | 2,412.23 |
| Pacific coast tide tables for western North America, eastern Asia, and many island groups, [calendar] year 1919; from General tide tables. (Serial 83.) 188 p. | 16,000 | 14,321 | 3,092.73 |
| Notice for Tide tables of 1919—Changes in limits of time zones. 1 p. | 10,000 | 10,000 | 14.23 |
| United States coast pilot, Atlantic coast, sec. A, St. Croix River to Cape Cod; [by L. A. Potter, under direction of Herbert C. Graves]. (Serial 99.) Aug. 23, 1918. 305 p. 1 map | 5,000 | 1,484 | 2,556.86 |
| Same, sec. B, Cape Cod to Sandy Hook; [by Harry Leypoldt, under direction of Herbert C. Graves]. (Serial 91.) May 24, 1918. 326 p. 2 maps. | 5,000 | 2,897 | 2,462.85 |
| Same, sec. D, Cape Henry to Key West; [by Herbert C. Graves, assisted by F. Vance Miller and J. T. Watkins]. July 1, 1913. [Reprint.] 231 p. 1 map | 1,500 | 1,500 | 491.12 |
| Same, sec. E, Gulf of Mexico from Key West to Rio Grande; [by Arthur J. Ela, under direction of R. S. Patton]. May 6, 1916. [Reprint.] 169 p. 1 map | 3,000 | 763 | 990.44 |
| Results of observations made at Survey magnetic observatory at Cheltenham, Md., 1915 and 1916; by Daniel L. Hazard. (Serial 94.) 112 p. 21 diag. 9x11½" | 900 | 743 | 1,758.14 |
| Results of magnetic observations made by Survey in 1918; by Daniel L. Hazard. (Special publication 55; serial 105.) 32 p. | 1,000 | 742 | 163.43 |
| Texas-California arc of primary triangulation; by William Bowie. (Special publication 11.) 1912. [Reprint.] 141 p. 2 pl. 6 p. of pl. 10 text fig. 9x11½" | 400 | 72 | 118.78 |
| Errata sheet. (Special publication 24.) 1 p. 9x11½" | 700 | 700 | 7.84 |
| Triangulation in Maine; by Walter F. Reynolds. (Special publication 46; serial 74.) 286 p. 1 pl. 21 maps | 2,000 | 233 | 2,913.38 |
| Connection of arcs of primary triangulation along 98th meridian in United States and in Mexico and on triangulation in southern Texas; by William Bowie. (Special publication 54; serial 97.) 93 p. 2 pl. 4 p. of pl. 7 maps. | 2,000 | 214 | 813.73 |
| Catalogue of charts, sailing directions, and tide tables of Philippine Islands. (Reprinted from General catalogue.) 1918. 52 p. 23 text fig. 8½x10¾" | 400 | 400 | 48.61 |
| Supplement to Catalogue of charts, coast pilots, and tide tables, 1918. July 10, 1918. (Serial 100.) 4 p. 8x10½" | 1,000 | 800 | 27.44 |
| Same. Jan. 4, 1919. (Serial 108.) 5 p. 8x10½" | 1,000 | 800 | 35.31 |
| Same. June 1, 1919. (Serial 114.) 6 p. 8x10½" | 700 | 175 | 42.86 |
| Construction and operation of wire drag; by J. H. Hawley. (Special publication 56; serial 107.) 40 p. 3 pl. 11 text fig. | 1,500 | 85 | 308.79 |
| Neglected waters of Pacific coast: Washington, Oregon, and California; by E. Lester Jones. (Special publication 48; serial 81.) 1918. [Reprint.] 21 p. 6 pl. 7 maps, 1 diag. 8x10½" | 1,000 | 293 | 112.45 |
| Safeguard the gateways of Alaska: Her waterways; by E. Lester Jones. (Special publication 50; serial 87.) 1918. [Reprint.] 41 p. 2 pl. 14 p. of pl. 21 maps, 4 diag. 1 paster. 8x10½" | 2,000 | 109 | 473.41 |
| Regulations for government of Survey. (Serial 101.) 170 p. 5½x8" | 500 | 500 | 588.76 |
| Uniform regulations for field corps of Survey. (Serial 102.) 16 p. 5 p. of text fig. | 500 | 500 | 65.32 |
| Specifications for construction of Survey vessel Advance. 90 p. 5x7" | 250 | 250 | 190.53 |
| Coast and Geodetic Survey [extract from Public Act No. 181, 65th Cong. making appropriations for sundry civil expenses, fiscal year 1919]. 4 p. | 200 | 200 | 7.26 |
| Important publications of Survey appearing since Jan. 1, 1914. (Serial 109.) 6 p. | 6,000 | 1,442 | 39.52 |
| Coast Survey bulletin [issued monthly, June, 1918–May, 1919, nos. 37–48, various paging.] 98 p. | 5,000 | 5,000 | 312.26 |

### BUREAU OF FISHERIES.

| | | | |
|---|---|---|---|
| Report of Commissioner, 1917, with appendixes. 433 p. 6 p. of pl. 10 text fig. | 250 | 171 | $263.69 |
| CONTENTS.—Report of Commissioner of Fisheries.—Distribution of fish and fish eggs, fiscal year 1917.—Alaska fisheries and fur industries, 1917; by Ward T. Bower and Henry D. Aller.—Mortality of fishes on west coast of Florida; by Harden F. Taylor.—Fish isinglass and glue; by George F. White.—The pikes: Their geographical distribution, habits, culture, and commercial importance; by William Converse Kendall.—Notes on life history of minnows Gambusia affinis and Cyprinodon variegatus; by Samuel F. Hildebrand. | | | |

## PUBLICATIONS ISSUED BY DEPARTMENT OF COMMERCE, AND DISTRIBUTION THEREOF, FISCAL YEAR 1919—Continued.

### BUREAU OF FISHERIES—Continued.

| Title and description. | Received. | Distributed. | Cost. |
|---|---|---|---|
| Bulletin, vol. 35, 1915–1916. 608 p. 19 pl. 27 p. of pl. 195 text fig. 7½x10½″<br>CONTENTS.—Histological basis of adaptive shades and colors in flounder Paralichthys albiguttus [with bibliography]; by Albert Kuntz.—Fishes of Lahontan system of Nevada and northeastern California; by John Otterbein Snyder.—Notes on embryology and larval development of 12 teleostean fishes; by Albert Kuntz and Lewis Radcliffe.—Occurrence in Virginia of green-gilled oysters similar to those of Marennes [with bibliography]; by Philip H. Mitchell and Raymond L. Barney.—Nutrition of oysters: Glycogen formation and storage; by Philip H. Mitchell.—Economic relations, anatomy, and life history of genus Lernæa: by Charles Branch Wilson.—Myxosporidia of Beaufort region: Systematic and biologic study [with bibliography]; by H. S. Davis.—Food of shore fishes of certain Wisconsin lakes [with bibliography]; by A. S. Pearse.—Fishes of Kentucky and Tennessee: Distributional catalogue of known species: by Barton Warren Evermann.—Decapod crustaceans of Beaufort, N. C., and surrounding region [with bibliography]; by W. P. Hay and C. A. Shore.—Nutrition of oysters: Nature of so-called "fattening" of oysters; by Philip H. Mitchell.—Rangeley Lakes, Me., with special reference to habits of fishes, fish culture, and angling; by William Converse Kendall. | 250 | 179 | $850.89 |
| Same [title-page, contents, and index only]. 14 p. | 750 | 447 | 128.54 |
| Bureau of Fisheries documents: | | | |
| 521. Artificial propagation of shad and pike perch. [From Fish manual.] [Reprint.] 43 p. 9 pl. 7 text fig. | 1,000 | 269 | 62.53 |
| 826. Fish ponds on farms; by Robert S. Johnson and M. F. Stapleton. [App. 2, Report of Commissioner, 1915.] Revised edition, 1917. [Reprint.] 32 p. 8 text fig. | 1,500 | 1,378 | 23.10 |
| 847. Alaska fisheries and fur industries in 1917; by Ward T. Bower and Henry D. Aller. [App. 2, Report of Commissioner, 1917.] 123 p. | 1,750 | 1,064 | 715.66 |
| 852. Fish isinglass and glue; by George F. White. [App. 4, Report of Commissioner, 1917.] [Reprint.] 15 p. 2 p. of pl. | 1,000 | 59 | 15.09 |
| 862. Annual report of Commissioner, 1918. 94 p. | 1,500 | 1,490 | 498.57 |
| 864. Three new whitefishes from Bear Lake, Idaho and Utah; by John Otterbein Snyder. [From Bulletin, v. 36.] 9 p. 3 text fig. 7½x10½″ | 1,000 | 948 | 68.71 |
| 867. Habits of black crappie in inland lakes of Wisconsin [with bibliography]; by A. S. Pearse. [App. 3, Report of Commissioner, 1918.] 16 p. 3 text fig. | 1,500 | 875 | 78.72 |
| 869. Flatworm as an enemy of Florida oysters; by Ernest Danglade. [App. 5, Report of Commissioner, 1918.] 8 p. 2 p. of pl. | 1,300 | 745 | 64.11 |
| **Economic circulars:** | | | |
| **29. Why and how to use salt and smoked fish: Sixty-one ways of cooking them; [by H. F. Moore]. Aug. 8, 1917. [Reprint.] 8 p.** | 50,000 | 15,814 | 165.64 |
| **30. Possibilities of food from fish; [by H. F. Taylor]. Aug. 28, 1917. [Reprint.] 4 p.** | 10,000 | 5,258 | 17.97 |
| **38. Whales and porpoises as food: With 32 recipes; [by Lewis Radcliffe]. Nov. 6, 1918. 10 p.** | 10,000 | 4,278 | 96.13 |
| **39. Artificial propagation of carp; [by G. C. Leach]. Jan. 18, 1919. 19 p. 9 text fig.** | 10,000 | 2,256 | 147.68 |
| **40. Capture and marketing of carp: Seasons and localities of capture; [by H. L. Canfield]. Sept. 20, 1918. 7 p.** | 10,000 | 2,091 | 58.34 |
| **41. Culture of rainbow trout and brook trout in ponds; [by Glen C. Leach]. Feb. 20, 1919. 19 p. 8 text fig.** | 2,500 | 1,913 | 80.79 |
| **Same [reprint]** | 3,000 | .......... | 29.97 |
| **42. Parasites of fresh-water fishes: Comprising some general considerations; [by H. S. Pratt]. Mar. 29, 1919. 8 p. 7 text fig.** | 2,000 | 1,765 | 56.43 |
| **43. Fresh-water mussels: Valuable national resource without sufficient protection; [by Hugh M. Smith]. Feb. 12, 1919. 5 p.** | 2,000 | 2,000 | 22.28 |
| **44. Groupers: Fishes you should try, with recipes for cooking them; [by H. F. Moore]. Mar. 21, 1919. 8 p. 1 text fig.** | 15,000 | 6,933 | 87.20 |
| **45. Marked Pacific salmon: Announcement regarding fish expected to return in 1919 and subsequent years; [by Willis H. Rich]. May 10, 1919. 12 p. 11 text fig.** | 2,500 | 2,500 | 75.21 |
| **Fisheries Service bulletin [issued monthly, July, 1918–June, 1919, nos. 38–49, 6–14 p. each]. 117 p.** | 12,000 | 12,000 | 424.13 |
| **Proposals for supplies, Pribilof Islands, Alaska, 1919 [with contract and bond]. 84 p. 7¾x10¼″** | 500 | 500 | 645.00 |
| **Specifications for construction of a laboratory building at biological station, Fairport, Iowa. 40 p.** | 100 | 100 | 132.12 |
| **Revised specifications for construction of laboratory building at biological station, Fairport, Iowa. 43 p.** | 100 | 100 | 134.88 |
| **Quantities and values of certain fishery products landed at Boston and Gloucester, Mass., and Portland, Me., by American fishing vessels [issued monthly, June, 1918–May, 1919; statistical bulletins 418, 420, 421, 424, 425, 427, 429, 434, 437, 439, 441, 443]. 12 numbers. 1 sheet each. Approx. 32x14″** | 4,800 | 4,800 | 610.45 |

## PUBLICATIONS ISSUED BY DEPARTMENT OF COMMERCE, AND DISTRIBUTION THEREOF, FISCAL YEAR 1919—Continued.

### BUREAU OF FISHERIES—Continued.

| Title and description. | Received. | Distributed. | Cost. |
|---|---|---|---|
| Quantities and values of certain fishery products landed at Seattle, Wash., by American fishing vessels and fishery products taken in Puget Sound and landed at Seattle, Wash., by collecting vessels [issued monthly, June, 1918–May, 1919; statistical bulletins 417, 419, 422, 423, 426, 428, 430, 435, 438, 440, 442, 444]. 12 numbers. 1 sheet each. 10½x8" | 4,800 | 4,800 | $114.32 |
| Quantities and values of certain fishery products landed at Boston and Gloucester, Mass., and Portland, Me., by American and Canadian fishing vessels, calendar year 1918, by months. (Statistical bulletin 432.) 1 sheet. 38x13" | 1,250 | 1,250 | 95.34 |
| Same, by fishing grounds. (Statistical bulletin 433.) 1 sheet. 38x21" | 1,250 | 1,250 | 116.29 |
| Quantities and values of certain fishery products landed at Seattle, Wash., by American fishing vessels, calendar year 1918, by fishing grounds and by months, and fishery products taken in Puget Sound and landed at Seattle, Wash., by collecting vessels, calendar year 1918, by months. (Statistical bulletin 431.) 1 sheet. 18x16" | 750 | 750 | 31.75 |
| Coastal fisheries of New York and New Jersey, by counties, exclusive of shellfish, 1917, and shad fishery of Hudson River, 1917 and 1918. (Statistical bulletin 416.) 1 sheet. 17x21" | 2,500 | 2,500 | 57.36 |
| Fisheries of Great Lakes, Lake of the Woods, and Rainy Lake in 1917, and yield of fisheries of Great Lakes for various years from 1885 to 1917. (Statistical bulletin 436.) 1 sheet. 15x19" | 2,500 | 2,500 | 47.95 |

### BUREAU OF FOREIGN AND DOMESTIC COMMERCE.

| | | | |
|---|---|---|---|
| Annual report of Chief, 1918. 93 p | 2,500 | 1,865 | $341.55 |
| Commerce reports [issued daily except Sundays and legal holidays, July 1, 1918–June 30, 1919, 306 issues, 8–32 p. each]. 5,760 p | 1,601,400 | 1,601,400 | 29,888.46 |
| Same, [title-page and index to] nos. 76–152, v. 2 [series 1918]; Apr.–June, 1918. 44 p | 1,000 | 1,000 | 305.68 |
| Same, [title-page and index to] nos. 153–229, v. 3 [series 1918]; July–Sept. 1918. 37 p | 1,000 | 1,000 | 250.50 |
| Same, [title-page and index to] nos. 230–306, v. 4 [series 1918]; Oct.–Dec. 1918. 32 p | 1,000 | 1,000 | 226.74 |
| Same, supplements [contain annual reports of United States consular officers on commercial conditions in foreign countries; 95 issues, various paging]. 1,095 p | 480,850 | 480,850 | 9,666.84 |
| Same, [title-page, contents, and] index. 16 p | 1,000 | 1,000 | 99.83 |
| Foreign tariff notes, no. 28. [From Commerce reports, Jan.–Mar. 1918.] 69 p | 1,000 | 464 | 147.87 |
| Same, no. 29 [with cumulative index for nos. 26 to 29]. [From Commerce reports, Apr.–June, 1918.] 84 p | 1,000 | 790 | 296.55 |
| Same, no. 30. [From Commerce reports, July–Sept. 1918.] 73 p | 1,000 | 603 | 188.31 |
| Uniform classification of international foreign trade statistics. [From Commerce reports, Jan. 6, 1919.] 11 p | 1,000 | 1,000 | 86.50 |
| Foreign commerce and navigation of United States, year ending June 30, 1918. [Printed also as H. doc. 1839, 65th Cong. 3d sess.] 1,090 p. 9x11½" | 2,000 | 1,784 | 12,873.98 |
| Separates reprinted from Foreign commerce and navigation, 1918 [all 9x11½"]: | | | |
| Classification of countries for tables of imports and exports (Schedule C). 21 | 1,000 | 100 | 3.49 |
| Imports of merchandise, by articles and countries, 1914–1918. [Table 3.] 282 p | 800 | 381 | 241.47 |
| Exports of domestic merchandise, by articles and countries, 1914–1918. [Table 5.] 505 p | 800 | 403 | 462.02 |
| Imported merchandise entered for consumption in United States and duties collected thereon, 1918. Total values of imported merchandise entered for consumption, by customs districts. [Summary tables and Tables 9–10.] 58 p | 800 | 382 | 136.61 |
| Statistical record of progress of United States, 1800–1918, and monetary, commercial, and financial statistics of principal countries; compiled by Edward Whitney. [From Statistical abstract of United States, 1917, with additional figures for 1918.] [Reprint.] 90 p | 1,000 | 288 | 169.82 |
| Statistical abstract of United States, 1918. No. 41. [Printed also as H. doc. 1611, 65th Cong. 3d sess.] 897 p | 3,000 | 2,167 | 4,799.55 |
| Total values of imports and exports of United States [issued monthly, June, 1918–May, 1919, 12 numbers, 2 p. each]. 24 p. 9x11½" | 14,400 | 14,400 | 209.75 |

## PUBLICATIONS ISSUED BY DEPARTMENT OF COMMERCE, AND DISTRIBUTION THEREOF, FISCAL YEAR 1919—Continued.

### BUREAU OF FOREIGN AND DOMESTIC COMMERCE—Continued.

| Title and description. | Received. | Distributed. | Cost. |
|---|---|---|---|
| Monthly summary of foreign commerce of United States [May, 1918–Apr. 1919, 12 numbers; printed also as H. doc. 601, pt. 11–12, 64th Cong. 2d sess., and H. doc. 1401, pt. 1–10, 65th Cong. 3d sess.; all 9x11½"]: | | | |
| May, 1918. 98 p | 2,850 | 2,850 | $1,837.80 |
| June, 1918. 98 p | 3,050 | 2,630 | 1,848.79 |
| July, 1918. 100 p | 2,850 | 2,820 | 1,947.69 |
| Aug. 1918. 100 p | 2,850 | 2,850 | 1,870.68 |
| Sept. 1918. 100 p | 2,850 | 2,850 | 1,881.38 |
| Oct. 1918. 100 p | 2,850 | 2,850 | 1,879.68 |
| Nov. 1918. 100 p | 2,850 | 2,850 | 1,851.33 |
| Dec. 1918. 100 p | 3,050 | 2,850 | 1,917.89 |
| Jan. 1919. 100 p | 2,850 | 2,850 | 1,875.98 |
| Feb. 1919. 100 p | 2,950 | 2,930 | 1,867.63 |
| Mar. 1919. 100 p | 2,950 | 2,651 | 1,859.27 |
| Apr. 1919. 100 p | 2,950 | 2,698 | 1,873.18 |
| Imported merchandise entered for consumption in United States and duties collected thereon during quarters ending Sept. 30 and Dec. 31, 1917, and Mar. 31, 1918. 113 p. 9x11½" | 850 | 850 | 1,051.25 |
| Same, quarters ending Sept. 30 and Dec. 31, 1917, and Mar. 31 and June 30, 1918. 113 p. 9x11½" | 850 | 850 | 1,026.05 |
| Same, quarters ending Sept. 30 and Dec. 31, 1918. 69 p. 9x11½" | 850 | 850 | 662.75 |
| Industrial standards series [specifications]; text as adopted by American Society for Testing Materials; Spanish-English editions, prepared under supervision of Bureau of Standards: | | | |
| 1. Portland cement. Revised, 1917. [Reprint.] 47 p. 2 p. of pl. 12 text fig | 500 | 141 | 28.39 |
| 2. Carbon steel rails. Revised, 1914. 27 p | 1,000 | 548 | 129.03 |
| 3. Open-hearth steel girder and high tee rails. Adopted, 1912. 19 p. | 1,000 | 498 | 118.13 |
| 4. Low-carbon steel splice bars. Revised, 1914. 15 p | 1,000 | 449 | 82.30 |
| 5. Medium-carbon steel splice bars. Revised, 1914. 15 p. 2 text fig. | 1,000 | 498 | 95.02 |
| 6. High-carbon steel splice bars. Revised, 1914. 15 p. 2 text fig | 1,000 | 447 | 95.63 |
| 7. Structural steel for bridges. Revised, 1916. 21 p. 4 text fig | 1,000 | 453 | 140.26 |
| 8. Structural steel for buildings. Revised, 1916. 21 p. 4 text fig | 1,000 | 525 | 108.26 |
| 9. Structural steel for locomotives. Revised, 1916. 19 p. 2 text fig | 1,000 | 498 | 88.62 |
| 10. Carbon steel bars for railway springs. Revised, 1916. 13 p | 1,000 | 572 | 63.48 |
| 11. Carbon steel and alloy steel forgings. Revised, 1918. 25 p. 2 text fig | 1,000 | 499 | 143.03 |
| 12. Quenched and tempered carbon-steel axles, shafts, and other forgings for locomotives and cars. Revised, 1918. 25 p. 2 text fig | 1,000 | 550 | 111.29 |
| 13. Carbon steel forgings for locomotives. Revised, 1916. 19 p. 2 text fig | 1,000 | 598 | 83.70 |
| 14. Carbon steel car and tender axles. Revised, 1918. 15 p | 1,000 | 344 | 103.84 |
| 15. Wrought solid carbon-steel wheels for steam railway service. Revised, 1916. 21 p. 3 text fig | 1,000 | 492 | 128.88 |
| 16. Steel tires. Revised, 1916. 15 p. 2 text fig | 1,000 | 403 | 93.94 |
| 17. Steel castings. Revised, 1916. 21 p. 2 text fig | 1,000 | 393 | 108.69 |
| 18. Lap-welded and seamless steel boiler tubes for locomotives. Revised, 1918. 19 p. 4 text fig | 1,000 | 425 | 153.14 |
| 19. Lap-welded and seamless steel and wrought-iron boiler tubes for stationary service. Revised, 1918. 19 p. 4 text fig | 1,000 | 425 | 138.10 |
| 20. Welded steel pipe. Revised, 1918. 15 p | 1,000 | 474 | 88.43 |
| 21. Boiler and fire-box steel for locomotives. Revised, 1918. 19 p. 2 text fig | 1,000 | 455 | 102.81 |
| 22. Boiler rivet steel. Revised, 1914. 15 p. 4 text fig | 1,000 | 443 | 86.81 |
| 23. Lap-welded charcoal-iron boiler tubes for locomotives. Revised, 1918. 15 p. 2 text fig | 1,000 | 476 | 95.23 |
| 24. Staybolt iron. Revised, 1918. 15 p | 1,000 | 430 | 74.37 |
| 25. Engine-bolt iron. Revised, 1918. 15 p | 1,000 | 394 | 86.75 |
| 26. Refined wrought-iron bars. Revised, 1918. 15 p | 1,000 | 417 | 93.11 |
| 27. Wrought-iron plates. Revised, 1918. 13 p | 1,000 | 428 | 87.20 |
| 28. Cast-iron pipe and special castings. Adopted, 1904. 27 p. 2 text fig | 1,000 | 474 | 181.15 |
| 29. Cast-iron locomotive cylinders. Revised, 1914. 15 p. 4 text fig | 1,000 | 341 | 96.20 |
| 30. Extra high-carbon-steel splice bar. Revised, 1914. 15 p. 2 text fig. | 1,000 | 428 | 91.78 |
| 31. Quenched high-carbon steel splice bars. Adopted, 1915. 15 p. 2 text fig | 1,000 | 423 | 84.98 |
| 32. Quenched carbon-steel track bolts. Revised, 1916. 15 p. 2 text fig. | 1,000 | 423 | 96.93 |
| 33. Quenched alloy-steel track bolts. Revised, 1916. 15 p. 2 text fig. | 1,000 | 423 | 82.33 |
| 34. Structural nickel steel. Revised, 1916. 21 p. 4 text fig | 1,000 | 428 | 139.68 |
| 35. Structural steel for cars. Revised, 1916. 19 p. 2 text fig | 1,000 | 428 | 120.35 |
| 36. Structural steel for ships. Revised, 1916. 19 p. 2 text fig | 1,000 | 702 | 120.10 |
| 37. Rivet steel for ships. Revised, 1914. 17 p. 4 text fig | 1,000 | 427 | 92.03 |
| 38. Billet-steel concrete-reinforcement bars. Revised, 1914. 17 p | 1,000 | 428 | 114.22 |
| 39. Rail-steel concrete-reinforcement bars. Revised, 1914. 13 p | 1,000 | 425 | 87.81 |
| 40. Cold-rolled steel axles. Revised, 1916. 15 p. 2 text fig | 1,000 | 426 | 84.68 |
| 41. Wrought solid carbon-steel wheels for electric railway service. Revised, 1916. 21 p. 2 text fig | 1,000 | 423 | 145.03 |

## PUBLICATIONS ISSUED BY DEPARTMENT OF COMMERCE, AND DISTRIBUTION THEREOF, FISCAL YEAR 1919—Continued.

### BUREAU OF FOREIGN AND DOMESTIC COMMERCE—Continued.

| Title and description. | Received. | Distributed. | Cost. |
|---|---|---|---|
| Industrial standard series—Continued. | | | |
| 42. Automobile carbon and alloy steels. Revised, 1918. 23 p. 4 text fig | 1,000 | 423 | $172.31 |
| 43. Cold-drawn Bessemer steel automatic screw stock. Adopted, 1914. 11 p | 1,000 | 423 | 79.91 |
| 44. Cold-drawn open-hearth automatic screw stock. Adopted, 1915. 11 p | 1,000 | 423 | 84.56 |
| 45. Iron and steel chain. Revised, 1918. 19 p | 1,000 | 343 | 123.15 |
| 46. Foundry pig iron. Revised, 1909. 13 p | 1,000 | 424 | 90.71 |
| 47. Cast-iron car wheels. Adopted, 1905. 21 p | 1,000 | 428 | 112.94 |
| 48. Malleable-iron castings. Revised, 1915. 13 p. 2 text fig | 1,000 | 430 | 88.39 |
| 49. Gray-iron castings. Revised, 1918. 15 p. 4 text fig | 1,000 | 424 | 77.63 |
| 50. Hard-drawn copper wire. Revised, 1915. 25 p. 4 text fig | 1,000 | 423 | 165.87 |
| 51. Medium hard-drawn copper wire. Revised, 1915. 21 p | 1,000 | 427 | 109.64 |
| 52. Soft or annealed copper wire. Revised, 1915. 15 p | 1,000 | 423 | 78.62 |
| 53. Lake copper wire bars, cakes, slabs, billets, ingots, and ingot bars. Revised, 1913. 15 p | 1,000 | 422 | 80.78 |
| 54. Electrolytic copper wire bars, cakes, slabs, billets, ingots, and ingot bars. Revised, 1913. 13 p | 1,000 | 422 | 77.64 |
| 55. Spelter. Revised, 1918. 21 p | 1,000 | 422 | 106.51 |
| 56. Manganese-bronze ingots for sand castings. Revised, 1914. 13 p. 2 text fig | 1,000 | 473 | 71.32 |
| 57. Purity of raw linseed oil from North American seed. Revised, 1915. 11 p | 1,000 | 423 | 72.41 |
| 58. Purity of boiled linseed oil from North American seed. Adopted, 1915. 11 p | 1,000 | 423 | 68.96 |
| 59. Turpentine. Adopted, 1915. 13 p | 1,000 | 424 | 77.28 |
| 60. Carbon-steel and alloy-steel blooms, billets, and slabs for forgings. Revised, 1918. 19 p | 1,000 | 473 | 108.30 |
| 61. Welded wrought-iron pipe. Adopted, 1918. 15 p | 1,000 | 473 | 69.93 |
| 62. Quenched and tempered alloy-steel axles, shafts, and other forgings for locomotives and cars. Revised, 1918. 25 p. 2 text fig | 1,000 | 422 | 146.69 |
| Special agents series: | | | |
| 167. Electrical goods in Bolivia and Chile; by Philip S. Smith. 94 p. 2 pl. 10 p. of pl | 1,000 | 424 | 411.57 |
| 169. Investments in Latin America and British West Indies; by Frederic M. Halsey. 544 p. 1 pl. 22 p. of pl | 1,000 | 754 | 2,436.10 |
| 170. Motor vehicles in Japan, China, and Hawaii; by Tom O. Jones. 75 p. 6 p. of pl | 1,000 | 524 | 281.60 |
| 171. Brazilian markets for paper, paper products, and printing machinery; by Robert S. Barrett. 77 p. 1 pl. 4 p. of pl | 1,000 | 481 | 316.76 |
| 172. Electrical goods in China, Japan, and Vladivostok; by R. A. Lundquist. 197 p. 1 pl. 8 p. of pl | 1,000 | 660 | 836.75 |
| 173. Shoe and leather trade of China and Japan; by C. E. Bosworth. 37 p | 1,000 | 465 | 157.74 |
| 174. Markets for boots and shoes in Chile and Bolivia; by Herman G. Brock. 192 p. 1 pl. 6 p. of pl | 1,000 | 490 | 782.08 |
| 175. Construction materials and machinery in Chile, Peru, and Ecuador; by W. W. Ewing. 205 p. 1 pl. 6 p. of pl | 1,000 | 599 | 794.42 |
| 176. Furniture markets of Chile, Peru, Bolivia, and Ecuador; by Harold E. Everley. 165 p. 1 pl. 16 p. of pl | 1,000 | 482 | 754.75 |
| 178. Advertising methods in Cuba; by J. W. Sanger. 47 p. 2 pl. 2 p. of pl. 5 text fig | 1,000 | 476 | 234.82 |
| Special consular reports: | | | |
| 81. Abyssinia: Present commercial status of country with special reference to possibilities for American trade; by Addison E. Southard. 71 p. 1 text fig | 1,000 | 473 | 236.70 |
| Tariff series: | | | |
| 39. British control of imports and exports, with lists of prohibited goods: by L. Domeratzky. June, 1918. 32 p | 1,000 | 580 | 130.75 |
| 39a. Supplement to British control of imports and exports, with lists of prohibited imports; by L. Domeratzky. May, 1919. 16 p | 1,000 | 379 | 60.44 |
| Miscellaneous series: | | | |
| 33. Ports of United States: Report on terminal facilities, commerce, port charges, and administration at 68 selected ports; by Grosvenor M. Jones. [Reprint.] 431 p. 1 pl. 20 charts | 500 | 279 | 280.08 |
| 63. Trade of United States with the world, 1916–1917: pt. 2, Exports of merchandise from United States, by countries and principal articles. 317 p | 1,000 | 645 | 2,682.97 |
| 67. Export lumber trade of United States; by Edward Ewing Pratt. 117 p. 1 pl. 8 p. of pl. 1 map, 20 text fig | 1,000 | 491 | 678.19 |
| 68. Wearing apparel in Argentina; prepared by Lew B. Clark. 158 p. 4 p. of pl. 1 text fig | 1,000 | 404 | 658.77 |
| 69. Wearing apparel in Bolivia; prepared by William A. Montavon. 84 p | 1,000 | 418 | 337.41 |

## PUBLICATIONS ISSUED BY DEPARTMENT OF COMMERCE, AND DISTRIBUTION THEREOF, FISCAL YEAR 1919—Continued.

### BUREAU OF FOREIGN AND DOMESTIC COMMERCE—Continued.

| Title and description. | Received. | Distributed. | Cost. |
|---|---|---|---|
| Miscellaneous series—Continued. | | | |
| 70. Conduct of business with China. 47 p. | 1,000 | 494 | $134.02 |
| 71. Wearing apparel in Brazil; prepared by William C. Downs. 64 p. | 1,000 | 370 | 265.26 |
| 72. Consumption estimates [from Statistical abstract of United States, 1917]. 14 p. | 1,000 | 354 | 27.48 |
| 73. Economic reconstruction: Analysis of main tendencies in principal belligerent countries of Europe, with statistics of production, consumption, and trade in important foodstuffs and industrial raw materials. 74 p. | 1,000 | 1,000 | 338.43 |
| 74. Wearing apparel in Peru; prepared by William F. Montavon. 64 p. | 1,000 | 411 | 242.32 |
| 75. Statistics of German trade, 1909 to 1913. [Reprinted from Miscellaneous series 57 and 65; by C. D. Snow, assisted by J. J. Kral.] 71 p. | 1,000 | 447 | 94.56 |
| 76. International trade in footwear other than rubber: Import statistics of boots and shoes for countries whose imports exceeded $300,000 in value and export statistics of countries whose exports exceeded $3,000,000 in value, 1908 and 1913; by Edward Whitney. 93 p. | 1,000 | 352 | 644.67 |
| 77. Statistics of Austro-Hungarian trade, 1909 to 1913; by J. J. Kral. 64 p. | 1,000 | 373 | 486.38 |
| 78. Trade of United States with the world, 1917–1918: pt. 1, Imports of merchandise into United States by countries and principal articles, during years ending June 30, 1917 and 1918. 112 p. | 1,000 | 796 | 1,080.75 |
| Same: pt. 2, Exports of merchandise from United States by countries and principal articles, during years ending June 30, 1917 and 1918. 346 p. | 1,000 | 754 | 3,116.99 |
| 79. International trade in cement: Import statistics for countries whose imports exceeded $200,000 in value and export statistics for countries whose exports exceeded $1,000,000 in value, 1908, 1913, and latest available year; by Edward Whitney. 76 p. | 1,000 | 719 | 472.69 |
| 80. Wholesale prices of leading articles in United States markets, Jan. 1917, to Dec. 1918; prepared by research division. 14 p. | 1,000 | 290 | 119.85 |
| 82. Chemicals and allied products used in United States: Imports by quantities, values, and countries of origin during fiscal year 1913–14 and statistics of domestic production; prepared by Bureau in collaboration with American Chemical Society, Dr. E. R. Pickrell, compiler. 194 p. | 1,000 | 920 | 1,776.16 |
| 83. Trade directory of South Australia; compiled by Henry P. Starrett. 31 p. | 1,000 | 275 | 137.36 |
| Schedule governing statistical classification of imports into United States, with rates of duty, and regulations governing preparation of monthly and quarterly statements of imports and monthly statement of exports of foreign commodities. [Supersedes and combines former Schedule A, "Classification of imports and exports of foreign commodities," and Schedule E, "Classification of imports for consumption."] Approved June 10, 1918. [Reprint.] 108 p. | 1,000 | 400 | 62.44 |
| Schedule B, Classification of commodities and regulations governing statistical returns of exports of domestic commodities, and shipments between United States and its noncontiguous territory. Approved May 25, 1917. [Reprint.] 23 p. | 2,000 | 2,000 | 30.30 |
| Same [reprint]. | 2,000 | 1,100 | 30.34 |
| Trade opportunities in France. Confidential bulletin 35. July 15, 1918. 73 p. | 1,000 | 1,000 | 239.68 |
| Are you interested in Latin American trade? [Reprint.] 4 p. 3½x8" | 3,500 | 3,500 | 9.76 |
| Government assistance to foreign buyers visiting United States [in English]. [Reprint.] 4 p. 3½x6¼" | 20,000 | 20,000 | 152.12 |
| Same [in French]. [Reprint.] 4 p. 3½x6¼" | 11,000 | 11,000 | |
| Same [in Spanish]. [Reprint.] 4 p. 3½x6¼" | 9,000 | 8,700 | |
| Same [in English]. [Reprint.] | 5,000 | 400 | 64.73 |
| Same [in French]. [Reprint.] | 10,000 | 1,200 | |
| Services to exporters rendered by Bureau. 20 p. 3½x5¼" | 25,000 | 15,000 | 341.99 |
| Monthly letter: Review of Bureau's activities at home and abroad. July 1, 1918. 20 p. | 300 | 300 | 38.82 |
| Same. Aug. 1, 1918. 23 p. | 300 | 300 | 40.62 |
| Appointments to positions at home and abroad in Bureau. 23 p. 3½x8" | 5,000 | 2,500 | 56.90 |
| Decimal system for indexed correspondence files, for use of Bureau and its district and commercial attaché offices. July, 1919. 67 p. | 300 | 300 | 200.16 |
| Regulations and instructions for trade commissioners. Jan. 1919. 31 p. 4x6½" | 500 | 500 | 64.79 |
| Catalogue of Bureau publications: Review of information available to manufacturers and exporters in bulletins issued by Bureau. June 15, 1918. 49 p. | 10,000 | 8,000 | 403.15 |
| List of publications [of Bureau] for sale by Superintendent of Documents, Government Printing Office, Washington, and by district and cooperative offices of Bureau. Corrected to Sept. 3, 1918. 12 p. 3½x8" | 6,000 | 6,000 | 57.12 |
| Same. Corrected to Apr. 1, 1919. 14 p. 3½x8" | 10,000 | 5,000 | 71.39 |

## BUREAU OF LIGHTHOUSES.

| Title and description. | Received. | Distributed. | Cost. |
|---|---|---|---|
| Annual report of Commissioner, 1918. 83 p. | 2,500 | 1,411 | $612.15 |
| Notice to mariners [issued weekly, jointly with Coast and Geodetic Survey, July 5, 1918–June 27, 1919, nos. 27–52+1–26. 52 numbers]. 662 l | 244,300 | 244,300 | 3,846.19 |
| Same [for posting, Atlantic coast nos. 61, 63, Pacific coast nos. 23–25, Gulf coast nos. 62, 64; 7 notices, each 10½x16"]. 7 l | 4,600 | 4,600 | 63.82 |
| Same [reprint of no. 62] | 600 | 600 | 8.83 |
| Lighthouse Service bulletin [issued monthly, July, 1918–June, 1919, vol. 2, nos. 7–18, 12 numbers, 4–8 p. each]. 52 p. | 18,000 | 18,000 | 217.82 |
| Light list, Atlantic and Gulf coasts of United States. [Includes also Porto Rico and adjacent islands.] Corrected to Jan. 1, 1919. 404 p. | 15,000 | 11,799 | 3,889.67 |
| Same, Pacific coast, United States, Canada, Hawaiian [Midway, Guam] and Samoan Islands. Corrected to Jan. 1, 1919. [Of Samoan Islands only Tutuila is included in this publication.] 178 p. | 3,000 | 2,504 | 986.94 |
| Same, Great Lakes, United States, and Canada. Corrected to Apr. 1, 1919. 219 p. | 2,500 | 1,383 | 875.76 |
| Same, upper Mississippi River and tributaries. 13th lighthouse district. Corrected to Jan. 15, 1919. 217 p. 3¼x6¼" | 1,500 | 1,206 | 736.65 |
| Same, Ohio, Tennessee, Kanawha, and Monongahela Rivers. 14th lighthouse district. Corrected to Sept. 15, 1918. 141 p. 3¼x6¼" | 1,100 | 1,051 | 166.14 |
| Same, lower Mississippi River and tributaries. 15th lighthouse district. Corrected to Nov. 15, 1918. 79 p. 3¼x6¼" | 1,500 | 1,500 | 129.34 |
| Atlantic coast of United States, buoy list, Narragansett Bay to Cape May, including New York Harbor. 3d lighthouse district. Corrected to May 15, 1919. 126 p. | 8,000 | 5,776 | 953.58 |
| Same, Delaware Bay and River, including Philadelphia Harbor. 4th lighthouse district. Corrected to June 1, 1917. [Reprint.] 34 p. | 1,500 | 1,500 | 26.57 |
| Same, corrected to June 1, 1919. 32 p. | 5,000 | 1,160 | 271.22 |
| Gulf coast, Cedar Keys to Rio Grande. 8th lighthouse district. Corrected to Sept. 1, 1918. 71 p. | 4,000 | 3,809 | 652.74 |
| West Indies, buoy list, Porto Rico and adjacent islands. [Includes Guantanamo Bay on south coast of Cuba, Navassa Island in northwest part of Caribbean Sea, and St. Thomas and St. Croix Islands, Virgin Islands.] 9th lighthouse district. Corrected to Nov. 15, 1918. 22 p. | 2,500 | 2,105 | 61.15 |
| Great Lakes, buoy list, Lake Erie and Lake Ontario and St. Lawrence River. 10th lighthouse district. Corrected to Apr. 1, 1919. 32 p. | 2,000 | 1,372 | 275.98 |
| Same, Lake Huron and Lake Superior and connecting waters. 11th lighthouse district. Corrected to Apr. 1, 1919. 62 p. | 2,000 | 1,369 | 592.00 |
| Same, Lake Michigan and Green Bay. 12th lighthouse district. Corrected to Apr. 1, 1919. 39 p. | 2,000 | 1,356 | 325.83 |
| Pacific coast, buoy list, Alaska. 16th lighthouse district. Corrected to Feb. 1, 1919. 38 p. | 200 | 195 | 118.14 |
| Same, Oregon and Washington. 17th lighthouse district. Corrected to June 1, 1919. 59 p. | 1,500 | 551 | 304.36 |
| Pacific islands, buoy list, Hawaiian and Samoan Islands. 19th lighthouse district. Corrected to Feb. 1, 1919. 20 p. | 200 | 93 | 127.89 |
| Regulations for United States Lighthouse Service, 1918. 209 p. | 650 | 448 | 618.86 |
| Plans and specifications for buoys and appendages. July 1, 1918. 8 p. 20 pl. | 1,500 | 1,500 | 289.57 |
| Plans and specifications for moorings for vessels and buoys. July 1, 1918. 8 p. 9 pl. | 1,500 | 1,500 | 95.51 |
| Specifications for single-screw, steel, steam-propelled first-class light vessel No. 105. 1919. 108 p. | 500 | 500 | 274.39 |

## BUREAU OF NAVIGATION.

| Title and description. | Received. | Distributed. | Cost. |
|---|---|---|---|
| Annual report of Commissioner, 1918 [with certain statistical tables for 1917]. [Printed also as H. doc. 1435, 65th Cong. 3d sess.] 237 p. | 1,000 | 862 | $2,188.33 |
| Supplement to List of merchant vessels of United States, year ended June 30, 1917. [Contains names of all vessels officially numbered during year ended June 30, 1918.] 36 p. 8¼x9⅝" | 5,000 | 5,000 | 657.12 |
| 50th annual list of merchant vessels of United States, with official numbers and signal letters, and lists of vessels belonging to Government, with distinguishing signals, year ended June 30, 1918. [pts. 1–5 and appendix] 540 p. 8¼x9⅝" | 5,000 | 4,956 | 8,177.38 |
| Seagoing vessels of United States, with official numbers and signal letters, 1918; pt. 6 of 50th annual list of merchant vessels of United States, year ended June 30, 1918. 109 p. 63 text fig. 8¼x9⅝" | 5,000 | 4,842 | 1,051.63 |
| First supplement to List of merchant vessels of United States, year ended June 30, 1918. [Contains names of all vessels officially numbered during six months ended Dec. 31, 1918.] 24 p. 8¼x9⅝" | 5,000 | 4,956 | 385.45 |
| American documented seagoing merchant vessels of 500 gross tons and over. [Issued monthly, Aug. 1, 1918–June 1, 1919, 11 numbers, 32–43 p. each.] 405 p. 9¼x11⅞" | 2,025 | 1,640 | 1,842.78 |
| Measurement of vessels: Regulations interpreting laws relating to admeasurement of vessels, together with laws of United States and Suez Canal regulations. 3d edition, with diagrams. Jan. 3, 1919. 111 p. 41 text fig. | 1,500 | 750 | 469.30 |
| Navigation laws of United States, 1915. [Reprint.] 585 p. | 500 | 432 | 325.35 |

## PUBLICATIONS ISSUED BY DEPARTMENT OF COMMERCE, AND DISTRIBUTION THEREOF, FISCAL YEAR 1919—Continued.

### BUREAU OF STANDARDS.

| Title and description. | Received. | Distributed. | Cost. |
|---|---|---|---|
| Annual report of Director, 1918. 206 p. 1 paster | 1,500 | 1,324 | $643.19 |
| Scientific papers [reprints from Bulletin; all 7x10″]: | | | |
| 11. Optical pyrometry; by C. W. Waidner and G. K. Burgess. 1905. [Reprint.] 68 p. 16 text fig | 500 | 141 | 62.86 |
| 13. Testing of clinical thermometers; by C. W. Waidner and L. A. Fischer. Nov. 1, 1905. [Reprint.] 17 p. 10 pl | 200 | 58 | 39.34 |
| 32. Heat treatment of high temperature mercurial thermometers; by Hobert C. Dickinson. Apr. 15, 1906. [Reprint.] 37 p. 8 text fig | 200 | 82 | 24.52 |
| 76. Influence of frequency on resistance and inductance of solenoidal coils; by Louis Cohen. Aug. 16, 1907. [Reprint.] 20 p. 1 text fig | 500 | 151 | 23.05 |
| 124. Platinum resistance thermometry at high temperatures [with bibliography]; by C. W. Waidner and G. K. Burgess. June 26, 1909. [Reprint.] 84 p. 4 pl. 4 text fig | 200 | 71 | 52.32 |
| 135. Specific heat of some calcium chloride solutions between −35° C and + 20° C; by H. C. Dickinson, E. F. Mueller, and E. B. George. Nov. 4, 1909. [Reprint.] 32 p. 1 pl. 8 text fig | 500 | 88 | 35.27 |
| 183. Benzoic acid as an acidimetric standard; by George W. Morey. May 14, 1912. [Reprint.] 8 p | 500 | 75 | 10.34 |
| 188. Instruments and methods used in radiometry, 2; by W. W. Coblentz. Dec. 8, 1911. [Reprint.] 59 p. 17 text fig | 500 | 77 | 55.35 |
| 219. Production of temperature uniformity in an electric furnace; by A. W. Gray. Feb. 3, 1914. [Reprint.] 25 p. 4 p. of pl. 9 text fig | 500 | 56 | 45.15 |
| 229. Various modifications of bismuth-silver thermopiles having a continuous absorbing surface; by W. W. Coblentz. Mar. 20, 1914. [Reprint.] 59 p. 3 pl. 7 text fig | 500 | 58 | 72.33 |
| 235. Direct-reading instrument for measuring logarithmic decrement and wave length of electromagnetic waves; by Frederick A. Kolster. Aug. 15, 1914. [Reprint.] 37 p. 5 pl. 17 text fig | 500 | 55 | 58.04 |
| 272. Correlation of magnetic and mechanical properties of steel [with bibliography]; by Charles W. Burrows. Mar. 29, 1916. [Reprint.] 40 p. 1 pl. 40 text fig | 500 | 79 | 46.95 |
| 278. An investigation of the laws of plastic flow; by Eugene C. Bingham. June 5, 1916. [Reprint.] 47 p. 1 pl. 12 text fig | 500 | 56 | 43.39 |
| 286. Determination of aluminium as oxide; by William Blum. Aug. 10, 1916. [Reprint.] 22 p. 2 text fig | 500 | 74 | 22.69 |
| 311. Axial aberrations of lenses; by E. D. Tillyer and H. I. Schultz. Nov. 3, 1917. 31 p. 27 text fig | 500 | 311 | 31.89 |
| 324. Wave lengths in the red and infra-red spectra of iron, cobalt, and nickel arcs; by W. F. Meggers and C. C. Kiess. June 29, 1918. 17 p | 500 | 469 | 114.24 |
| 325. Spectroradiometric investigation of transmission of various substances; by W. W. Coblentz, W. B. Emerson, and M. B. Long. Aug. 8, 1918. 26 p. 20 text fig | 1,000 | 385 | 145.77 |
| 326. Electrical oscillations in antennas and inductance coils; by John M. Miller. Oct. 23, 1918. 22 p. 7 text fig | 1,000 | 460 | 145.39 |
| 327. Measurements on index of refraction of air for wave lengths from 2218 A to 9000 A; by W. F. Meggers and C. G. Peters. Oct. 31, 1918. 46 p. 2 pl. 4 text fig | 1,000 | 365 | 299.78 |
| 328. Variance of measuring instruments and its relation to accuracy and sensitivity; by Frederick J. Schlink. Sept. 30, 1918. 26 p. 7 text fig | 1,000 | 835 | 134.83 |
| 329. Measurements of wave lengths in spectrum of neon; by Keivin Burns, W. F. Meggers, and Paul W. Merrill. Nov. 12, 1918. 13 p | 1,000 | 295 | 81.83 |
| 330. Decrease in ultra-violet and total radiation with usage of quartz mercury vapor lamps; by W. W. Coblentz, M. B. Long, and H. Kahler. Nov. 12, 1918. 22 p. 6 text fig | 1,000 | 355 | 127.72 |
| 331. Relation connecting derivatives of physical quantities; by Mayo D. Hersey. Dec. 30, 1918. 10 p | 1,000 | 1,000 | 71.45 |
| 332. Preliminary determination of thermal expansion of molybdenum; by Lloyd W. Schad and Peter Hidnert. Jan. 29, 1919. 10 p. 2 text fig | 1,000 | 116 | 73.91 |
| 333. Optical conditions accompanying striæ which appear as imperfections in optical glass; by Lieut. Commander A. A. Michelson. Mar. 20, 1919. 5 p. 4 text fig | 500 | 125 | 31.40 |
| 334. New forms of instruments for showing presence and amount of combustible gas in air; by E. R. Weaver and E. E. Weibel. June 23, 1919. 46 p. 2 pl. 19 text fig | 1,500 | 125 | 291.96 |
| 336. Simplification of inverse-rate method for thermal analysis; by P. D. Merica. June 11, 1919. 4 p. 1 text fig | 1,000 | 136 | 19.36 |
| Circulars [all 7x10″]: | | | |
| 3. Design and test of standards of mass. 3d edition. Dec. 23, 1918. 89 p. 5 pl. 25 text fig | 2,000 | 1,759 | 722.46 |
| 7. Pyrometer testing and heat measurements. 5th edition. Oct. 1, 1913. [Reprint.] 19 p | 500 | 298 | 22.60 |

| Title and description. | Received. | Distributed. | Cost. |
|---|---|---|---|
| Circulars—Continued. | | | |
| 8. Testing of thermometers. 2d edition, revised and enlarged. June 30, 1911. [Reprint.] 52 p. 1 text fig | 200 | 200 | $29.06 |
| 11. Standardization of bomb calorimeters. 3d edition. June 23, 1917. [Reprint.] 18 p | 500 | 140 | 21.15 |
| 14. Analyzed irons and steels—Methods of analysis. 5th edition. Mar. 20, 1916. [Reprint.] 17 p | 500 | 103 | 21.16 |
| 16. Testing of hydrometers. 4th edition. Feb. 23, 1916. [Reprint.] 16 p. 1 pl. 2 text fig | 500 | 106 | 27.50 |
| 19. Standard density and volumetric tables. 5th edition. Mar. 30, 1916. [Reprint.] 67 p | 500 | 414 | 56.74 |
| 20. Electrical measuring instruments. 2d edition. May 28, 1915. [Reprint.] 58 p | 1,000 | 147 | 86.39 |
| 24. Publications of Bureau of Standards. 5th edition. Apr. 14, 1919. 149 p | 10,000 | 1,712 | 1,760.10 |
| Same [supplement 1], supplementing, up to Apr. 15, 1919, list published in Circular 24, 5th edition. 4 p | 2,500 | 2,345 | 27.12 |
| Standard samples issued or in preparation. Supplement to Circular 25. Apr. 1, 1919. 6 p | 1,000 | 777 | 45.49 |
| 27. Properties and testing of optical instruments. 2d edition. Aug. 9, 1918. 41 p. 1 text fig | 1,000 | 760 | 153.29 |
| 31. Copper wire tables. 3d edition. Oct. 1, 1914. [Reprint.] 76 p. 4 text fig | 500 | 141 | 68.99 |
| 32. Standards for gas service. 3d edition. Mar. 10, 1915. Supersedes 2d edition, Standard regulations for manufactured gas and gas service, and 1st edition, State and municipal regulations for quality, distribution, and testing of illuminating gas.] [Reprint.] 197 p | 500 | 74 | 146.34 |
| 35. Melting points of chemical elements, and other standard temperatures. 3d edition. July 15, 1918. 2 p | 500 | 500 | 19.28 |
| 38. Testing of rubber goods [with bibliography]. 3d edition. July 19, 1915. [Reprint.] 89 p. 35 text fig | 500 | 409 | 69.96 |
| 41. Testing and properties of textile materials. 2d edition. Aug. 27, 1915. 16 p. 8 text fig | 500 | 500 | 14.93 |
| Same, Testing of textile materials. 3d edition. Sept. 20, 1918. [Supersedes 2d edition, Testing and properties of textile materials.] 15 p. 7 text fig | 500 | 500 | 82.93 |
| Same [reprint] | 500 | 157 | 14.93 |
| 48. Standard methods of gas testing [with bibliography]. 2d edition. June 10, 1916. [Reprint.] 202 p. 1 pl. 16 text fig | 1,000 | 278 | 281.67 |
| 54. National electrical safety code [for examination, trial, and constructive criticism]. 2d edition. Nov. 15, 1916. [Reprint.] 323 p. 16 text fig | 1,000 | 509 | 364.24 |
| 57. United States standard tables for petroleum oils. 2d edition. May 11, 1916. [Reprint.] 64 p. 2 text fig | 500 | 93 | 68.89 |
| Same, supplementary petroleum oil tables: 1, Temperature corrections to readings of specific gravity hydrometers in American petroleum oils at various temperatures; 2, Temperature corrections to readings of Baumé hydrometers in American petroleum oils at various temperatures. [Reprint.] 2 p | | | |
| Same, supplementary petroleum oil tables 3 and 4. Aug. 27, 1915. [Reprint.] 2 p | | | |
| Same, supplementary petroleum oil tables: 5, Temperature corrections to apparent specific gravities of petroleum oils; 6, Temperature corrections to apparent degrees Baumé of petroleum oils. Jan. 7, 1916. [Reprint.] 2 p | | | |
| 59. United States standard Baumé hydrometer scales. Apr. 5, 1916. [Reprint.] 13 p | 500 | 109 | 20.32 |
| 62. Specifications for and methods of testing soaps. 2d edition. June 17, 1919. 32 p | 1,500 | 191 | 149.86 |
| 72. Scope and application of national electrical safety code. 1st edition. June 17, 1918. [Reprint.] 84 p | 3,000 | 631 | 267.96 |
| 74. Radio instruments and measurements [with bibliography]. Mar. 23, 1918. [Reprint.] 341 p. 1 pl. 12 p. of pl. 199 text fig | 2,500 | 2,500 | 1,084.61 |
| Same [reprint] | 500 | 307 | 419.10 |
| 76. Aluminum and its light alloys [with bibliography]. Apr. 21, 1919. 120 p. 2 p. of pl. 27 text fig | 1,000 | 801 | 871.90 |
| 77. Table of unit displacement of commodities. 1st edition. Mar. 10, 1919. 67 p | 2,000 | 881 | 871.35 |
| 78. Solders for aluminum. Jan. 28, 1919. 9 p. 2 p. of pl | 1,500 | 1,324 | 116.82 |
| 79. Electrical characteristics and testing of dry cells. Apr. 25, 1919. 44 p. 1 pl. 10 text fig | 1,500 | 908 | 308.28 |
| 82. Recommended specification for linseed oil—Raw, refined, and boiled. (Prepared and recommended by United States Interdepartmental Committee on Paint Specification Standardization, Apr. 16, 1919.) 9 p | 2,500 | 246 | 69.11 |

| Title and description. | Received. | Distributed. | Cost. |
|---|---|---|---|
| Technologic papers [all 7x10″]: | | | |
| 4. Effect of added fatty and other oils upon carbonization of mineral lubricating oils; by C. E. Waters. Aug. 24, 1911. [Reprint.] 14 p. | 500 | 81 | $18.42 |
| 8. Rapid method for determination of vanadium in steels, ores, etc., based on its quantitative inclusion by phosphomolybdate precipitate; by J. R. Cain and J. C. Hostetter. Oct. 26, 1911. [Reprint.] 20 p. 2 text fig. | 500 | 190 | 24.96 |
| 9. Density and thermal expansion of linseed oil and turpentine (including conversion tables of pounds to gallons and gallons to pounds); by H. W. Bearce. Apr. 15, 1912. [Reprint.] 27 p. | 500 | 156 | 66.74 |
| Same [supplement]. Table 1, for reducing observed specific gravities of turpentine at various temperatures to true specific gravity at 60°/60° F; Table 2, for reducing observed degrees Baumé of turpentine at various temperatures to true degrees Baumé at 60° F. Oct. 25, 1915. [Reprint.] 2 p. | | | |
| Same [supplement]. Table 3, showing degrees Baumé, pounds per gallon, and gallons per pound corresponding to various specific gravities of turpentine; Table 4, showing specific gravity, pounds per gallon, and gallons per pound corresponding to various degrees Baumé of turpentine. Oct. 25, 1915. [Reprint.] 2 p. | | | |
| 10. Melting points of fire bricks; by C. W. Kanolt. June 15, 1912. [Reprint.] 17 p. 1 pl. 3 text fig. | 1,000 | 54 | 39.81 |
| 11. Comparison of five methods used to measure hardness; by Ralph P. Devries. July 22, 1912. [Reprint.] 27 p. 1 pl. 11 text fig. | 500 | 87 | 37.41 |
| 12. Action of salts in alkali water and sea water on cements [with bibliography]; by P. H. Bates, A. J. Phillips, and Rudolph J. Wig. Nov. 1, 1912. [Reprint.] 157 p. 8 pl. 45 text fig. | 500 | 64 | 157.56 |
| 13. Evaporation test for mineral lubricating and transformer oils; by C. E. Waters. Jan. 1, 1913. [Reprint.] 13 p. | 500 | 100 | 18.40 |
| 20. Determination of sulphur in illuminating gas; by R. S. McBride and E. R. Weaver. Mar. 7, 1913. [Reprint.] 46 p. 14 text fig. | 500 | 80 | 43.85 |
| 24. Determination of phosphorus in steels containing vanadium; by J. R. Cain and F. H. Tucker. May 17, 1913. [Reprint.] 11 p. | 500 | 91 | 19.94 |
| 36. Industrial gas calorimetry; by C. W. Waidner and E. F. Mueller. Mar. 1, 1914. [Reprint.] 150 p. 18 pl. 12 text fig. | 500 | 112 | 191.93 |
| 41. Lead acetate test for hydrogen sulphide in gas; by R. S. McBride and J. D. Edwards. Aug. 19, 1914. [Reprint.] 46 p. 7 pl. 4 p. of pl. 8 text fig. | 500 | 131 | 87.64 |
| 49. Emergent stem correction for thermometers in creosote oil distillation flasks; by R. M. Wilhelm. Aug. 14, 1915. [Reprint.] 21 p. 6 text fig. | 500 | 60 | 24.87 |
| 52. Electrolysis and its mitigation; by E. B. Rosa and Burton McCollum. 2d edition. Nov. 25, 1918. 137 p. 4 pl. 32 text fig. | 2,000 | 1,053 | 781.28 |
| 69. Determination of carbon in steels and irons by direct combustion in oxygen at high temperatures; by J. R. Cain and H. E. Cleaves. Feb. 18, 1916. [Reprint.] 10 p. 3 text fig. | 500 | 176 | 11.23 |
| 70. Durability of stucco and plaster construction (progress report containing results of investigations up to Apr., 1916); by R. J. Wig, J. C. Pearson, and W. E. Emley. Jan. 31, 1917. [Reprint.] 74 p. 2 pl. 7 p. of pl. 6 text fig. 1 paster. | 1,000 | 496 | 158.24 |
| 77. Density and thermal expansion of American petroleum oils; by H. W. Bearce and E. L. Peffer. Aug. 26, 1916. [Reprint.] 4 p. | 500 | 115 | 28.61 |
| 80. Constitution and microstructure of porcelain; by A. A. Klein. Dec. 8, 1916. [Reprint.] 38 p. 1 pl. 14 p. of pl. 1 text fig. | 500 | 53 | 78.95 |
| 91. Temperature measurements in Bessemer and open-hearth practice; by George K. Burgess. May 8, 1917. [Reprint.] 29 p. 1 pl. | 500 | 74 | 32.94 |
| 92. Measurement and specification of physical factors which determine saturation of certain tints of yellow; by Irwin G. Priest and Chauncey G. Peters. June 30, 1917. [Reprint.] 11 p. 3 pl. 5 text fig. | 500 | 53 | 22.59 |
| 93. Glasses for protecting eyes from injurious radiations; by W. W. Coblentz and W. B. Emerson. 3d edition. Feb. 28, 1919. 25 p. 12 text fig. | 1,500 | 587 | 96.04 |
| 101. Tests of large bridge columns; by J. H. Griffith and J. G. Bragg. June 27, 1918. 139 p. 2 pl. 18 p. of pl. 46 text fig. | 1,500 | 349 | 999.26 |
| 104. Effect of size of grog in fire-clay bodies; by F. A. Kirkpatrick. Mar. 12, 1918. [Reprint.] 39 p. 29 text fig. | 1,000 | 388 | 59.70 |
| 109. Conservation of tin in bearing metals, bronzes, and solders; by G. K. Burgess and R. W. Woodward. Mar. 15, 1919. 9 p. | 500 | 493 | 58.85 |
| 110. Influence of quality of gas and other factors on efficiency of gas-mantle lamps; by R. S. McBride, W. A. Dunkley, E. C. Crittenden, and A. H. Taylor. Oct. 25, 1918. 49 p. 1 pl. 12 text fig. | 2,500 | 1,021 | 369.33 |
| 111. Compressive strength of large brick piers; by J. G. Bragg. Sept. 20, 1918. 39 p. 2 pl. 8 p. of pl. 14 text fig. | 1,500 | 1,288 | 345.76 |
| Same [reprint] | 1,000 | | 92.17 |

## PUBLICATIONS ISSUED BY DEPARTMENT OF COMMERCE, AND DISTRIBUTION THEREOF, FISCAL YEAR 1919—Continued.

### BUREAU OF STANDARDS—Continued.

| Title and description. | Received. | Distributed. | Cost. |
|---|---|---|---|
| Technologic papers—Continued. | | | |
| 112. Standardization of Saybolt universal viscosimeter; by Winslow H. Herschel. 2d edition. Apr. 30, 1919. 25 p. 4 text fig. | 1,500 | 417 | $82.58 |
| 114. Portable cubic-foot standard for gas; by M. H. Stillman. Jan. 28, 1919. 13 p. 1 pl. 3 text fig. | 1,500 | 716 | 93.51 |
| 115. New Baumé scale for sugar solutions; by Frederick J. Bates and H. W. Bearce. Oct. 30, 1918. 11 p. | 1,000 | 898 | 98.27 |
| Same [reprint] | 1,000 | ........ | 19.00 |
| 116. Silica refractories: Factors affecting their quality and methods of testing raw materials and finished ware; by Donald W. Ross. Apr. 19, 1919. 84 p. 2 pl. 14 p. of pl. 10 text fig. | 1,000 | 165 | 657.09 |
| 117. Toluol recovery; by R. S. McBride, C. E. Reinicker, and W. A. Dunkley. Dec. 19, 1918. 60 p. 1 pl. 1 text fig. | 2,500 | 1,220 | 390.34 |
| 118. Critical study of Ledebur method for determining oxygen in iron and steel; by J. R. Cain and Earl Pettijohn. Jan. 11, 1919. 33 p. 7 text fig. | 1,500 | 291 | 223.11 |
| 119. Ultra-violet and visible transmission of eye-protective glasses; by K. S. Gibson and H. J. McNicholas. June 7, 1919. 47 p. 1 pl. 24 text fig. | 1,000 | 852 | 320.32 |
| 120. Tests of hollow building tiles; by Bernard D. Hathcock and Edward Skillman. Feb. 8, 1919. 29 p. 1 pl. 8 text fig. | 1,500 | 621 | 198.84 |
| 125. Viscosity of gasoline; by Winslow H. Herschel. May 5, 1919. 18 p. 4 text fig. | 1,000 | 361 | 114.56 |
| 126. Study of Goutal method for determining carbon monoxide and carbon dioxide in steels; by J. R. Cain and Earl Pettijohn. Apr. 30, 1919. 8 p. | 1,000 | 272 | 42.38 |
| 128. Effect of solar radiation upon balloons; by Junius David Edwards and Maurice Blaine Long. June 13, 1919. 29 p. 1 pl. 6 text fig. | 1,000 | 292 | 195.63 |
| Miscellaneous publications: | | | |
| 1. Manual of inspection and information for weights and measures officials; by F. S. Holbrook. Nov. 14, 1918. 246 p. 2 text fig. 4⅝x6⅝" | 2,500 | 2,114 | 884.81 |
| 19. Proceedings of second annual textile conference, held at Bureau of Standards, Washington, May 21–22, 1917. 87 p. 1 pl. 8. p. of pl. 5 text fig. 7x10" | 1,000 | 293 | 426.76 |
| 21. Metric manual for soldiers. 16 p. 5 text fig. 4x6" | 10,000 | 10,000 | 109.87 |
| Same [reprint] | 100,000 | 65,807 | 408.93 |
| Publications of Bureau. July 5, 1918. [Reprinted from Department list.] 16 p. | 2,000 | 2,000 | 18.67 |
| Twelfth annual conference on weights and measures of United States, May 21–24, 1919. [Program.] 7 p. 5x7¾" | 350 | 350 | 40.55 |

### STEAMBOAT-INSPECTION SERVICE.

| Title and description. | Received. | Distributed. | Cost. |
|---|---|---|---|
| Annual report of Supervising Inspector General, 1918. 38 p. | 1,000 | 939 | $294.46 |
| General rules and regulations prescribed by board of supervising inspectors: | | | |
| Ocean and coastwise, amended Jan. 1918; further amended Mar. 15 and 16, and Apr. 3, 1918. Edition Apr. 8, 1918. [Reprint.] 205 p. 8 text fig. | 20,000 | 17,216 | 1,552.17 |
| Great Lakes, amended Jan. 1918; further amended Mar. 15, Apr. 3, and May 11, 1918. Edition May 29, 1918. 155 p. 5 text fig. | 10,000 | 10,000 | 834.63 |
| Same [reprint] | 10,000 | 2,501 | 597.53 |
| Lakes other than Great Lakes, bays, and sounds, amended Jan. 1918; further amended Mar. 15, Apr. 3, May 11, and June 5, 1918. Edition Aug. 1, 1918. 155 p. 5 text fig. | 10,000 | 10,000 | 783.87 |
| Same [reprint] | 10,000 | 633 | 588.14 |
| Rivers, amended Jan. 1918; further amended Mar. 15, Apr. 3, May 11, June 5, Aug. 5, and Sept. 24, 1918. Edition Nov. 19, 1918. 145 p. 5 text fig. | 15,000 | 14,715 | 1,018.48 |
| Eighteenth supplement to General rules and regulations. Apr. 7, 1919. (Circular letter.) 16 p. | 35,000 | 35,000 | 276.79 |
| Same [reprint] | 5,000 | 2,600 | 35.04 |
| Laws governing Steamboat-Inspection Service; Revised Statutes as modified by acts of Congress. Edition Mar. 5, 1919. 90 p. | 20,000 | 2,550 | 980.93 |
| Pilot rules for certain inland waters of Atlantic and Pacific coasts and of coast of Gulf of Mexico. Edition Aug. 14, 1917. [Reprint.] 32 p. 5 text fig | 50,000 | 50,000 | 665.07 |
| Same [reprint] | 50,000 | 18,635 | 716.96 |
| Pilot rules for rivers whose waters flow into Gulf of Mexico and their tributaries and Red River of North. Edition Aug. 1, 1911. [Reprinted Aug. 1, 1917, with modified boundary lines of inland waters.] 22 p. 5 text fig. | 10,000 | 639 | 139.37 |
| Steamboat-Inspection Service bulletin [issued monthly, July 1, 1918–June 2, 1919, nos. 33–44, 2–4 p. each]. 28 p. | 28,900 | 28,900 | 117.41 |

printed in two or more editions during 1919, against 13 in 1918, while 93, compared with 87 last year, were reprinted without change of issues of earlier years.

The publications issued in 1919 contained a total of 53,291 printed pages, compared with 42,644 in 1918, and there were printed of them for the Department a grand total of 4,638,725 copies, against 4,804,180 in the preceding year, a decrease of 165,455.

The average edition of the publications in 1919 was 4,562 copies, against 4,210 in 1918, while the average number of pages in the 1919 publications was 52, compared with 37 in 1918.

The total cost of all publications issued in 1919 was $306,340.39, compared with $300,382.75 in 1918.

The following recapitulation of the table, together with summary figures for 1917 and 1918, is submitted for comparative purposes:

| Bureau or office. | Publications. | | | Pages. | | |
|---|---|---|---|---|---|---|
| | 1917 | 1918 | 1919 | 1917 | 1918 | 1919 |
| Office of the Secretary | 78 | 70 | 82 | 3,006 | 2,860 | 2,212 |
| Bureau of the Census | 135 | 83 | 49 | 13,161 | 4,528 | 17,282 |
| Coast and Geodetic Survey | 62 | 55 | 40 | 3,097 | 5,378 | 3,458 |
| Bureau of Fisheries | 81 | 91 | 65 | 2,440 | 2,852 | 1,808 |
| Bureau of Foreign and Domestic Commerce | 553 | 544 | 554 | 17,803 | 16,372 | 17,519 |
| Bureau of Lighthouses | 111 | 100 | 93 | 3,087 | 3,517 | 2,910 |
| Bureau of Navigation | 22 | 16 | 8 | 3,102 | 1,576 | 2,047 |
| Bureau of Standards | 122 | 158 | 104 | 6,628 | 4,591 | 5,169 |
| Steamboat-Inspection Service | 28 | 24 | 21 | 2,088 | 970 | 886 |
| Total | 1,192 | 1,141 | 1.016 | 54,407 | 42,644 | 53,291 |

| Bureau or office. | Copies printed for Department. | | | Cost.[a] | | |
|---|---|---|---|---|---|---|
| | 1917 | 1918 | 1919 | 1917 | 1918 | 1919 |
| Office of the Secretary | 183,550 | 231,050 | 964,350 | $7,157.60 | $6,909.31 | $12,947.92 |
| Bureau of the Census | 645,150 | 427,875 | 215,350 | 92,562.23 | 73,150.95 | 86,301.14 |
| Coast and Geodetic Survey | 109,300 | 93,600 | 88,050 | 25,577.94 | 37,775.82 | 26,927.71 |
| Bureau of Fisheries | 339,700 | 981,840 | 159,350 | 11,681.49 | 13,833.18 | 6,014.94 |
| Bureau of Foreign and Domestic Commerce | 2,411,450 | 2,235,850 | 2,368,900 | 114,937.10 | 107,359.38 | 114,848.62 |
| Bureau of Lighthouses | 270,800 | 309,050 | 327,650 | 18,720.83 | 19,129.80 | 16,521.10 |
| Bureau of Navigation | 52,750 | 22,065 | 25,025 | 14,303.72 | 12,435.29 | 15,097.34 |
| Bureau of Standards | 138,300 | 238,950 | 215,150 | 21,202.22 | 23,154.69 | 19,180.87 |
| Steamboat-Inspection Service | 293,200 | 263,900 | 274,900 | 9,870.44 | 6,634.33 | 8,600.85 |
| Total | 4,444,200 | 4,804,180 | 4,638,725 | 316,013.57 | 300,382.75 | 306,440.49 |

[a] Figures relate to publications actually delivered to the Department during the year; consequently they do not agree with similar figures in a preceding table giving the cost of work done by the Government Printing Office during the fiscal year. Frequently the cost of a publication is charged against allotments for two or more fiscal years.

## DISTRIBUTION OF PUBLICATIONS.

In explanation of the apparent discrepancy between statistics of distribution in the following statements and those of publications issued, given in a preceding table, it should be stated that a considerable proportion of the publications of the Department is printed for official use only or is distributed through the bureaus or their field offices. The statistics following relate only to distribution through the Division of Publications.

Division of Publications, compared with a total of 3,863,594 during the fiscal year 1918. Of the total number distributed in 1919, 3,196,805 were wrapped and mailed by the Superintendent of Documents and 603,698 by the Division of Publications. Those wrapped and mailed by the Superintendent of Documents comprised a mailing-list distribution of 3,066,289 and a distribution in response to individual requests of 130,516.

There were received and acted on during the year 57,738 miscellaneous requests, calling for 419,689 copies of publications, compared with 61,538 requests, calling for 568,703 copies in 1918. This was an average of 192 requests and 1,399 publications for each working day, against an average of 205 requests and 1,896 publications during the preceding year.

The number of publications distributed each month during the past three fiscal years is shown in the following table:

| Month. | Mailed by Division. | | | Mailed by Superintendent of Documents. | | | Total. | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1917 | 1918 | 1919 | 1917 | 1918 | 1919 | 1917 | 1918 | 1919 |
| July | 50,668 | 90,773 | 98,088 | 216,879 | 242,292 | 302,512 | 267,547 | 333,065 | 400,600 |
| August | 19,733 | 58,264 | 60,186 | 359,800 | 240,480 | 284,511 | 379,533 | 298,744 | 344,697 |
| September | 10,415 | 73,291 | 28,153 | 297,628 | 215,227 | 178,741 | 308,043 | 288,518 | 206,894 |
| October | 21,286 | 58,383 | 50,933 | 290,363 | 198,854 | 205,663 | 311,649 | 257,237 | 256,596 |
| November | 27,241 | 55,263 | 28,204 | 274,623 | 250,364 | 241,364 | 301,864 | 305,627 | 269,568 |
| December | 24,637 | 81,162 | 27,701 | 231,637 | 230,766 | 321,519 | 256,274 | 311,928 | 349,220 |
| January | 24,784 | 102,247 | 24,849 | 239,300 | 298,496 | 490,737 | 264,084 | 400,743 | 515,586 |
| February | 19,206 | 134,872 | 37,933 | 235,049 | 193,948 | 210,945 | 254,255 | 328,820 | 248,878 |
| March | 52,354 | 88,281 | 43,922 | 185,798 | 247,395 | 228,477 | 238,152 | 335,676 | 272,399 |
| April | 47,017 | 39,191 | 92,769 | 361,556 | 240,953 | 269,083 | 408,573 | 280,144 | 361,852 |
| May | 83,177 | 61,544 | 42,012 | 203,885 | 235,106 | 235,869 | 287,062 | 296,650 | 277,881 |
| June | 58,937 | 218,018 | 68,948 | 257,590 | 208,424 | 227,384 | 316,527 | 426,442 | 296,332 |
| Total | 439,455 | 1,061,289 | 603,698 | 3,154,108 | 2,802,305 | 3,196,805 | 3,593,563 | 3,863,594 | 3,800,503 |

The distribution of publications in 1917, 1918, and 1919, by bureaus and offices of issue, is given in the following table:

| Bureau or office. | Mailed by Division. | | | Mailed by Superintendent of Documents. | | | Total. | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1917 | 1918 | 1919 | 1917 | 1918 | 1919 | 1917 | 1918 | 1919 |
| Office of the Secretary | 132,149 | 274,466 | 304,459 | 33,680 | 52,292 | 55,226 | 165,829 | 326,758 | 359,685 |
| Bureau of the Census [a] | ...... | ...... | ...... | 333,965 | 190,089 | 326,718 | 333,965 | 190,089 | 326,718 |
| Coast and Geodetic Survey | 4,825 | 4,800 | 4,900 | 26,231 | 32,322 | 13,451 | 31,056 | 37,122 | 18,351 |
| Bureau of Corporations (Federal Trade Commission) [b] | ...... | ...... | ...... | 4,744 | ...... | ...... | 4,744 | ...... | ...... |
| Bureau of Fisheries | 140,979 | 649,759 | 186,784 | 93,809 | 21,298 | 9,892 | 234,788 | 671,057 | 196,676 |
| Bureau of Foreign and Domestic Commerce | 73,392 | 80,092 | 16,208 | 2,217,515 | 2,112,232 | 2,248,478 | 2,290,907 | 2,192,324 | 2,264,686 |
| Bureau of Lighthouses | 10,444 | 5,846 | 7,476 | 256,116 | 274,653 | 342,386 | 266,560 | 280,499 | 349,862 |
| Bureau of Navigation | 3,599 | 840 | 781 | 46,897 | 12,095 | 24,207 | 50,496 | 12,935 | 24,988 |
| Bureau of Standards | ...... | ...... | ...... | 140,082 | 105,604 | 175,499 | 140,082 | 105,604 | 175,499 |
| Steamboat - Inspection Service | 74,067 | 45,486 | 83,090 | 1,069 | 1,720 | 948 | 75,136 | 47,206 | 84,038 |
| Total | 439,455 | 1,061,289 | 603,698 | 3,154,108 | 2,802,305 | 3,196,805 | 3,593,563 | 3,863,594 | 3,800,503 |

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[a] The Bureau of the Census has charge of the distribution of its own publications. Figures showing the number of copies mailed by the Superintendent of Documents were obtained from that Bureau.

[b] Pending the complete organization of the Federal Trade Commission during 1917, its publications were distributed by courtesy through the Division of Publications.

to publications of the Bureau of the Census, which accounts for the absence of figures for that Bureau.

| Bureau or office. | 1915 | 1916 | 1917 | 1918 | 1919 |
|---|---|---|---|---|---|
| Office of the Secretary | 14,546 | 20,152 | 17,448 | 20,823 | 26,330 |
| Coast and Geodetic Survey | 35,673 | 33,714 | 48,366 | 51,166 | 52,001 |
| Bureau of Fisheries | 112,934 | 117,964 | 223,700 | 575,309 | 499,974 |
| Bureau of Foreign and Domestic Commerce | 48,374 | 60,608 | 87,975 | 114,357 | 149,322 |
| Bureau of Lighthouses | 21,427 | 23,548 | 22,030 | 43,393 | 19,672 |
| Bureau of Navigation | 5,874 | 2,812 | 3,257 | 9,546 | 3,535 |
| Bureau of Standards | 131,750 | 138,435 | 132,511 | 180,030 | 227,387 |
| Steamboat-Inspection Service | 315 | 500 | 396 | 106 | 159 |
| Total | 370,893 | 397,733 | 535,683 | 994.730 | 978,380 |

As a result of the increasing number of different publications of the Department of permanent interest and value and the reprinting of publications from time to time to prevent stocks thereof from becoming exhausted, the number of publications available for distribution usually increases from year to year, as shown by the foregoing statement. The unusual increase shown for 1918 and 1919 over previous years was due to the printing in 1918 and 1919 of large editions of circulars issued by the Bureau of Fisheries on the use of fish as food and also to the printing in 1919 of 110,000 copies of a small pamphlet entitled "Metric Manual for Soldiers," issued by the Bureau of Standards.

## SALES OF PUBLICATIONS.

Many of the publications of the Department are printed in limited editions, and free distribution is made to only certain classes, such as Government officials, Members of Congress, commercial organizations, libraries, and educational institutions. The miscellaneous distribution is made through the office of the Superintendent of Documents on a sales basis. On January 1, 1919, under special authority of Congress (sec. 4, act of June 20, 1918), the light and buoy lists issued by the Bureau of Lighthouses were placed on a sales basis, the free distribution being confined to official uses.

The following statement of sales of the Department's publications, and receipts therefrom, during the past three years is compiled from figures furnished by the Superintendent of Documents.

### MISCELLANEOUS SALES.

| Bureau or office. | 1917 | | 1918 | | 1919 [a] | |
|---|---|---|---|---|---|---|
| | Copies. | Receipts. | Copies. | Receipts. | Copies. | Receipts. |
| Office of the Secretary | 106 | $11.85 | 45 | $11.90 | 942 | $244.65 |
| Bureau of the Census | 2,026 | 1,082.40 | 2,596 | 1,406.00 | 2,565 | 955.70 |
| Coast and Geodetic Survey | 505 | 210.60 | 597 | 195.15 | 635 | 148.85 |
| Bureau of Fisheries | 7,612 | 608.55 | 2,223 | 541.20 | 1,257 | 262.24 |
| Bureau of Foreign and Domestic Commerce | 73,745 | 14,420.30 | 58,011 | 10,481.55 | 86,924 | 16,791.04 |
| Bureau of Lighthouses | 398 | 69.15 | 220 | 61.40 | 1,917 | 344.50 |
| Bureau of Navigation | 7,210 | 1,555.90 | 1,498 | 488.80 | 2,220 | 647.71 |
| Bureau of Standards | 31,262 | 5,769.95 | 24,816 | 3,774.55 | 19,976 | 3,701.35 |
| Steamboat-Inspection Service | 32 | 3.90 | 41 | 5.20 | 29 | 3.70 |
| Total | 122,896 | 23,732.60 | 90,047 | 16,965.75 | 116,465 | 23,099.74 |

[a] Preliminary figures.

| Bureau and publication. | Subscriptions. | Receipts. | Subscriptions. | Receipts. | Subscriptions. | Receipts. |
|---|---|---|---|---|---|---|
| Bureau of Foreign and Domestic Commerce: | | | | | | |
| Commerce Reports | 7,282 | $18,131.81 | 5,825 | $14,481.04 | 7,196 | $17,869.80 |
| Quarterly Index to Commerce Reports | | | 36 | 6.95 | 72 | 14.35 |
| Bound volumes of Commerce Reports | 111 | 327.60 | 78 | 463.50 | 66 | 384.00 |
| Monthly Summary of the Foreign Commerce of the United States | 495 | 741.75 | 553 | 822.30 | 673 | 1,000.80 |
| Quarterly Statement of Imported Merchandise Entered for Consumption | 135 | 101.05 | 80 | 60.00 | 133 | 99.75 |
| Bureau of Navigation: Radio Service Bulletin [b] | 500 | 125.15 | | | | |
| Bureau of Standards: Bulletin | 305 | 301.50 | 89 | 87.25 | 84 | 82.50 |
| Total | 8,828 | 19,728.86 | 6,661 | 15,921.04 | 8,224 | 19,451.20 |

SUMMARY.

| Distribution. | 1917 | | 1918 | | 1919 [a] | |
|---|---|---|---|---|---|---|
| | Copies. | Receipts. | Copies. | Receipts. | Copies. | Receipts. |
| Through miscellaneous sales | 122,896 | $23,732.60 | 90,047 | $16,965.75 | 116,465 | $23,099.74 |
| By annual subscriptions | 3,402,430 | 19,728.86 | 2,884,213 | 15,921.04 | 2,478,186 | 19,451.20 |
| Total | 3,525,326 | 43,461.46 | 2,974,260 | 32,886.79 | 2,594,651 | 42,550.94 |

[a] Preliminary figures.

[b] The issuance of the Radio Service Bulletin was discontinued on account of the war, with the number for March, 1917. Its publication was resumed in August, 1919.

Coast pilots, inside route pilots, tide tables, and charts are sold by the Coast and Geodetic Survey, receipts from these sales being $19,854.01 in 1917; $20,194.19 in 1918; and $24,620.71 in 1919. Thus, the total receipts from sales of the publications of the Department during the past three years were: 1917, $63,315.47; 1918, $53,080.98; 1919, $67,171.65.

## MAILING LISTS.

On July 1, 1919, there were in the Division 349 mailing lists, containing 285,928 names, compared with 350 lists, with 285,877 names, a year ago. During the year 26,486 names were added to the lists and 26,435 were dropped from them; also 5 new lists were established and 6 were discontinued. There was, therefore, a decrease for the year of 1 list and a net increase of 51 names. More than 13,000 changes of address of persons on existing mailing lists were also made.

Stencils or plates are in use for 336 lists, with 280,569 names, of which the stencils or plates for 240 lists, with 235,605 names, are preserved in the Division, and those for 96 lists, with 44,964 names, are kept in the office of the Superintendent of Documents. A year ago stenciled or embossed plates were in use for 337 lists, with 273,008 names, of which 239 lists, with 201,766 names, were in the Division, and 98 lists, with 71,242 names, were at the office of the Superintendent of Documents. For 13 lists, containing 5,359 names, compared with 13 lists, containing 12,860 names, a year ago, address plates have not been embossed, the lists being preserved in card form only.

tion and preparation for the printer of manuscripts of all publications of the Department. The more important details of this work embrace a careful analysis of all manuscripts submitted for printing, with a view to the elimination of irrelevant subject matter or illustrations, preparation of typographical style in harmony with good printing practice, rearrangement of statistical statements to secure logical and economical results, critically reading and revising all proofs before approving for printing, and writing indexes for the more important reports of the Department. Reprints of publications and job work of every description also receive careful scrutiny, and proofs of form letters and other work done on duplicating machines are read and revised in this section.

In this connection it is deemed proper to call attention to the fact that more than 75 per cent of the allotment for printing and binding for the Department is expended for publications of various kinds, and to keep such expenditures within due bounds careful editing and preparation of manuscripts are necessary. This work requires not only long experience and careful training, but a certain degree of natural aptitude on the part of editorial clerks. These are qualifications which comparatively few persons possess, and those who do are in such constant demand by both Government departments and private employers that more than ordinary inducements in the way of compensation are ever being held out to the more capable of them. Owing to the limited salaries which the Department has heretofore paid to men equipped to do this work, it has not always nor even as a rule been possible to procure and retain the best talent in this line. A great deal has been accomplished, however, by editorial clerks in this Division, whose knowledge of matters having to do with the production of books has resulted in many economies. At the same time much attention has been given to the matter of improving the character of publications, in order that the highest standard may be attained.

The volume of work now devolving on the few editorial clerks in the Division is so great that all of it can not possibly be given the attention it deserves and should receive. For this reason, it is desired to emphasize the recommendation carried in the Division's personnel estimates for 1921 that the editorial and proof-reading force be enlarged. It is a sound conviction that every folio of manuscript should be carefully read, edited, and prepared before being forwarded to the Government Printing Office, and that every proof should be revised equally as carefully before being returned to the printer. To do this work properly would require several additional clerks, and it is believed that the beneficial results that would be obtained thereby would abundantly justify an increased expenditure for salaries.

### DUPLICATING AND MAILING WORK.

The following statements show increases over previous years in the various operations of this section of the Division.

The output of the machines for duplicating typewritten letters and documents for each month of the last three years was as follows:

| Month. | Requisitions. | | | Pages duplicated. | | | Copies printed. | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1917 | 1918 | 1919 | 1917 | 1918 | 1919 | 1917 | 1918 | 1919 |
| July | 275 | 306 | 184 | 578 | 693 | 533 | 341,760 | 777,302 | 494,504 |
| August | 307 | 367 | 210 | 703 | 806 | 504 | 410,015 | 709,545 | 436,455 |
| September | 283 | 255 | 255 | 799 | 528 | 528 | 384,067 | 542,840 | 542,840 |
| October: | 318 | 272 | 197 | 670 | 612 | 464 | 403,287 | 507,361 | 337,212 |
| November | 257 | 271 | 243 | 535 | 602 | 450 | 391,207 | 441,935 | 403,884 |
| December | 320 | 286 | 287 | 705 | 611 | 709 | 475,961 | 579,941 | 510,239 |
| January | 330 | 308 | 429 | 682 | 574 | 990 | 711,734 | 487,903 | 708,426 |
| February | 265 | 316 | 377 | 621 | 614 | 1,248 | 753,689 | 471,264 | 798,776 |
| March | 317 | 302 | 417 | 746 | 625 | 997 | 790,705 | 593,438 | 904,681 |
| April | 278 | 312 | 322 | 572 | 661 | 833 | 535,809 | 598,792 | 843,651 |
| May | 334 | 296 | 329 | 712 | 535 | 812 | 729,646 | 443,365 | 786,490 |
| June | 320 | 275 | 376 | 602 | 584 | 854 | 661,635 | 613,709 | 750,714 |
| Total | 3,604 | 3,566 | 3,626 | 7,925 | 7,445 | 8,922 | 6,589,515 | 6,767,395 | 7,517,872 |

These figures represent an increase of 60, or 1.68 per cent, in the number of jobs; an increase of 1,477, or 19.84 per cent, in the number of pages; and an increase of 750,477, or 11.09 per cent, in the number of copies printed.

Also the mechanical equipment of the section was utilized for folding 2,696,524 letters and documents (an increase of 56.96 per cent), sealing and mailing 1,650,266 envelopes (an increase of 5.3 per cent), and the addressing of 4,056,065 envelopes, franks, cards, and tags (an increase of 18.71 per cent).

In addition to the mechanical output, sheets inserted in envelopes (work which must be done entirely by hand) numbered 1,377,674, an increase of 16.07 per cent.

## ADVERTISING.

During the fiscal year 1919 the Department expended $2,969.21 for advertising for proposals for furnishing supplies of various kinds for construction work, and for the purchase of condemned property. Records pertaining to these advertisements are maintained in the Division of Publications, which makes up the authorizations to publish and checks and certifies the vouchers for payment.

The following statement shows for each of the past five years, by bureaus and offices, the number of advertisements inserted, the number of authorities to publish issued (one authority being made up for each paper authorized to issue each advertisement), the number of insertions authorized, and the total cost of such advertisements:

| Bureau or office. | Advertisements inserted. | | | | | Authorities to publish issued. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1915 | 1916 | 1917 | 1918 | 1919 | 1915 | 1916 | 1917 | 1918 | 1919 |
| Office of the Secretary | 3 | 2 | 3 | 12 | 8 | 15 | 10 | 6 | 36 | 31 |
| Bureau of the Census | .... | .... | .... | .... | 6 | .... | .... | .... | .... | 15 |
| Coast and Geodetic Survey | 23 | 11 | 29 | 23 | 18 | 93 | 43 | 73 | 51 | 77 |
| Bureau of Fisheries | 10 | 11 | 9 | 17 | 16 | 56 | 52 | 33 | 59 | 55 |
| Bureau of Foreign and Domestic Commerce | .... | 4 | 3 | .... | .... | .... | 14 | 11 | .... | .... |
| Bureau of Lighthouses | 182 | 186 | 183 | 204 | 193 | 594 | 579 | 546 | 590 | 592 |
| Bureau of Navigation | .... | 1 | .... | .... | .... | .... | 5 | .... | .... | .... |
| Bureau of Standards | 8 | 8 | 10 | 19 | 37 | 39 | 29 | 39 | 50 | 142 |
| Total | 226 | 223 | 237 | 275 | 278 | 797 | 732 | 708 | 786 | 898 |

| Bureau or office. | Insertions authorized. | | | | | Total cost. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1915 | 1916 | 1917 | 1918 | 1919 | 1915 | 1916 | 1917 | 1918 | 1919[a] |
| Office of the Secretary | 44 | 30 | 18 | 80 | 89 | $88.03 | $65.85 | $31.02 | $142.22 | $167.09 |
| Bureau of the Census | | | | | 45 | | | | | 94.94 |
| Coast and Geodetic Survey | 225 | 122 | 190 | 123 | 134 | 343.33 | 190.59 | 209.23 | 207.56 | 262.20 |
| Bureau of Fisheries | 142 | 135 | 81 | 119 | 119 | 174.62 | 195.80 | 123.94 | 231.61 | 236.20 |
| Bureau of Foreign and Domestic Commerce | | 42 | 11 | | | | 76.67 | 57.97 | | |
| Bureau of Lighthouses | 1,636 | 1,606 | 1,408 | 1,527 | 1,512 | 2,234.74 | 1,930.40 | 1,582.73 | 1,792.35 | 1,952.62 |
| Bureau of Navigation | | 20 | | | | | 24.30 | | | |
| Bureau of Standards | 96 | 82 | 108 | 145 | 424 | 217.42 | 101.27 | 185.66 | 120.52 | 256.16 |
| Total | 2,143 | 2,037 | 1,816 | 1,994 | 2,323 | 3,058.14 | 2,584.88 | 2,190.55 | 2,494.26 | 2,969.21 |

[a] Figures subject to slight revision, owing to a few estimates of cost having been made in cases where newspapers have delayed rendering bills.

The above statement shows that there was an increase in 1919 in the number of advertisements inserted, the number of authorities to publish issued, the number of insertions authorized, and the total cost. The average number of newspapers used for each advertisement was 3.23 in 1919 and 2.86 in 1918, and the average number of insertions in each newspaper was 2.59 in 1919 and 2.54 in 1918. The average cost for advertising in each case was $10.68 in 1919 and $9.07 in 1918, while the average cost per insertion of an advertisement was $1.28 in 1919 and $1.25 in 1918.

## ESTIMATE FOR PRINTING AND BINDING, 1921.[a]

The Division's estimate for printing and binding for the Department, exclusive of the Bureau of the Census, for 1921 is $386,430, an increase of $86,430 as compared with the appropriation for 1920. The total of the estimates submitted by the several bureaus and offices is $427,009. The several amounts asked for have been reviewed by the Division of Publications, with the result that reductions in the sum of $40,579 have been made.

The accompanying table shows the expenditures for each of the fiscal years 1915 to 1919, inclusive; average expenditures for the five-year period; suballotments for 1920; and estimates (both of the bureaus and the Division of Publications) for 1921 for printing and binding for the Department of Commerce, by bureaus, offices, and services.

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[a] On Sept. 5, 1919, the Department was informed by the Public Printer that, beginning Oct. 1, 1919, the present scale of charges for work done at the Government Printing Office would be increased 10 per cent. This increase has been included in the estimate submitted for 1921.

## EXPENDITURES FOR PRINTING AND BINDING FOR THE DEPARTMENT OF COMMERCE, BY BUREAUS, OFFICES, AND SERVICES, FOR EACH OF THE FISCAL YEARS 1915–1919; AVERAGE EXPENDITURES FOR THE FIVE-YEAR PERIOD; SUBALLOTMENTS FOR 1920; AND ESTIMATES FOR 1921.

[In presenting the estimates for 1921 consideration has been given to a letter from the Public Printer, dated Sept. 5, 1919, stating that, beginning Oct. 1, 1919, the scale of prices for printing and binding done at the Government Printing Office will be advanced 10 per cent.]

| Bureau, office, or service. | Expenditures. | | | | | | Suballotments for 1920. | Estimates, 1921. | |
|---|---|---|---|---|---|---|---|---|---|
| | 1915 | 1916 | 1917 | 1918 | 1919 | Average, 1915–1919. | | Bureau. | Division. |
| Office of the Secretary (Secretary, Assistant Secretary, Solicitor, Chief Clerk, and Division of Publications) | $19,537.58 | $16,581.71 | $15,432.08 | $18,388.96 | $17,112.36 | $17,410.54 | $17,000.00 | $18,700.00 | $18,700.00 |
| Appointment Division | 379.22 | 236.86 | 373.00 | 651.23 | 645.34 | 457.13 | 450.00 | 770.00 | 770.00 |
| Disbursing Office | 412.18 | 747.23 | 696.21 | 564.78 | 1,101.97 | 704.47 | 750.00 | 990.00 | 990.00 |
| Division of Supplies | 686.04 | 601.39 | 184.85 | 202.55 | 344.32 | 403.83 | 225.00 | 330.00 | 330.00 |
| Bureau of the Census | 122,302.82 | 84,766.94 | 115,971.35 | 96,487.31 | 113,971.18 | 106,699.92 | (a) | (a) | (a) |
| Coast and Geodetic Survey | 26,345.70 | 28,795.27 | 28,685.67 | 45,610.93 | 30,607.79 | 32,009.07 | 35,000.00 | 44,044.00 | 41,800.00 |
| Bureau of Fisheries | 15,916.27 | 12,460.20 | 16,432.46 | 15,364.28 | 12,393.97 | 14,513.44 | 16,000.00 | 16,500.00 | 16,500.00 |
| Bureau of Foreign and Domestic Commerce | 103,229.74 | 131,262.35 | 121,529.73 | 118,617.02 | 120,198.30 | 118,967.42 | 128,000.00 | 204,710.00 | 176,000.00 |
| Bureau of Lighthouses | 24,428.15 | 21,080.27 | 18,569.17 | 18,586.42 | 16,595.33 | 19,851.87 | 20,000.00 | 24,200.00 | 22,000.00 |
| Lighthouse Service | 5,853.89 | 7,208.17 | 4,771.61 | 6,443.32 | 7,580.02 | 6,371.40 | 7,000.00 | 8,250.00 | 8,250.00 |
| Bureau of Navigation | 14,183.91 | 16,928.50 | 14,740.06 | 12,902.86 | 16,856.98 | 15,122.46 | 16,000.00 | 18,700.00 | 17,600.00 |
| Shipping and Radio Services | 2,977.97 | 5,373.24 | 3,081.34 | 3,887.74 | 6,471.36 | 4,358.33 | 4,000.00 | 7,150.00 | 7,150.00 |
| Bureau of Standards | 24,876.38 | 35,824.68 | 23,649.34 | 35,638.74 | 32,548.55 | 30,507.54 | 30,000.00 | 50,325.00 | 44,000.00 |
| Office of the Supervising Inspector General, Steamboat-Inspection Service | 2,801.64 | 2,335.03 | 1,009.08 | 1,760.34 | 1,187.98 | 1,818.81 | 1,300.00 | 1,540.00 | 1,540.00 |
| Steamboat-Inspection Service | 9,780.49 | 14,466.86 | 10,701.05 | 9,795.13 | 13,192.28 | 11,587.16 | 10,000.00 | 13,200.00 | 13,200.00 |
| Customs Service | 9,287.49 | 11,169.58 | 6,775.76 | 10,050.63 | 9,153.59 | 9,287.41 | 10,000.00 | 11,000.00 | 11,000.00 |
| Bureau of Corporations (now Federal Trade Commission) | 17,000.00 | | | | | | | | |
| Reserve | | | | | | | 4,275.00 | 6,600.00 | 6,600.00 |
| Total | 399,999.47 | 389,838.28 | 382,602.76 | 394,952.24 | 399,961.32 | | 300,000.00 | 427,009.00 | 386,430.00 |
| Allotment | 400,000.00 | 390,000.00 | 400,000.00 | 400,000.00 | [b]400,023.47 | | 300,000.00 | | |
| Services for which expenditures were chargeable against allotments from the national security and defense fund: | | | | | | | | | |
| Waste-Reclamation Service | | | | | 684.20 | | | | |
| Industrial Cooperation Service | | | | | 4,854.43 | | | | |
| Industrial Board | | | | | 35.33 | | | | |

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[a] During the decennial census period (July 1, 1919–June 30, 1922) printing and binding for the Bureau of the Census will be paid for from the appropriation provided for the Fourteenth Census.

[b] Of this amount $23.47 represents a credit received from the Chief of Engineers, War Department, in payment for blank forms furnished that office by the Coast and Geodetic Survey.

ceding pages, the Division has received the helpful and harmonious cooperation of the several bureaus and offices of the Department. It is desired to acknowledge also the excellent service received from the Government Printing Office in connection with the Department's printing and binding, as is evidenced by the fact that at the close of the year the unused balance of the Department's printing allotment was only $62.15.

Respectfully,

T. F. McKeon,
*Chief, Division of Publications.*

To Hon. William C. Redfield,
*Secretary of Commerce.*

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